metals and alloys

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Volume 6 **Number 7** **July, 1935**

The Magazine of Metallurgical Engineering

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TREATMENT **APPLICATION**

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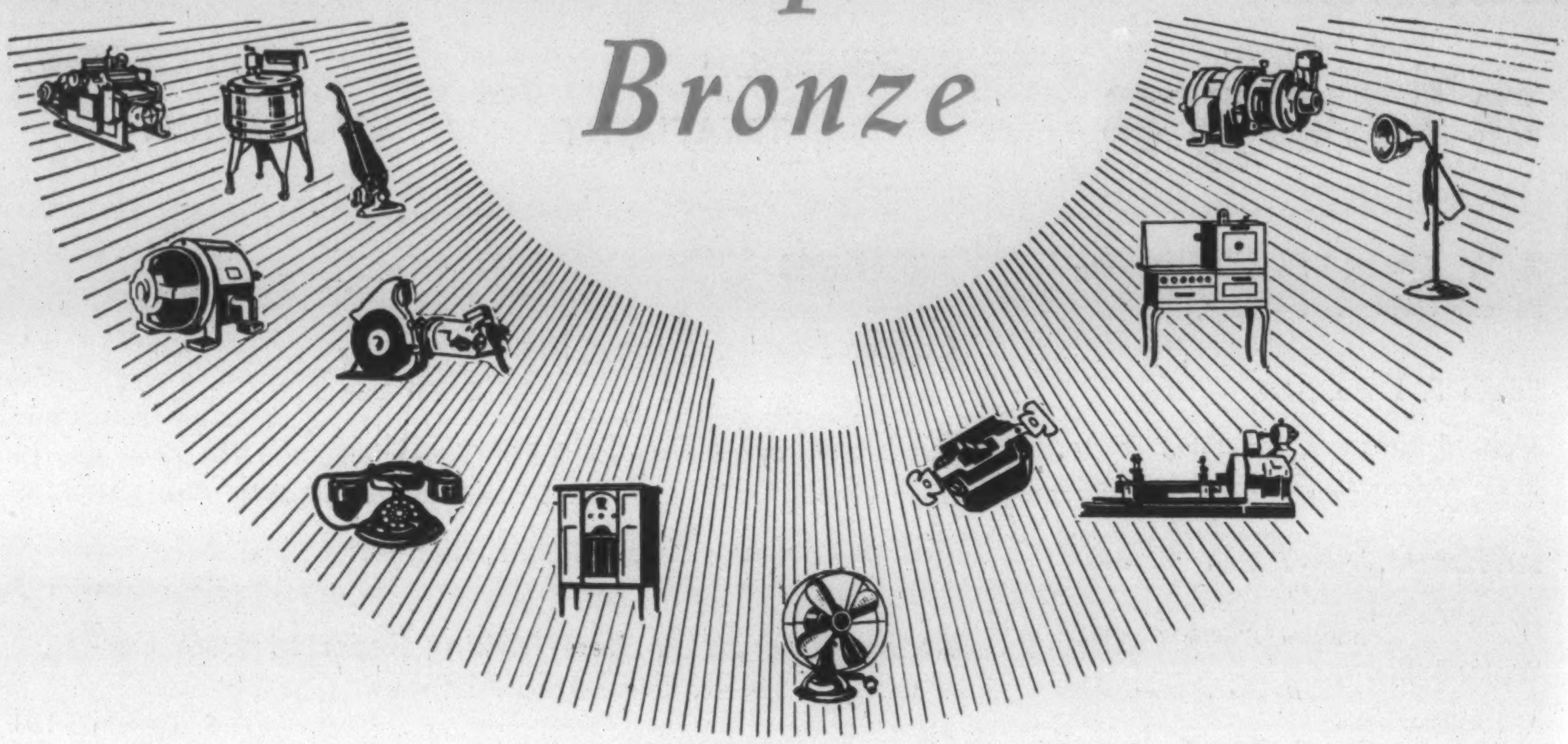
ELEPHANT BRAND

1874 *Phosphor Bronze* 1935



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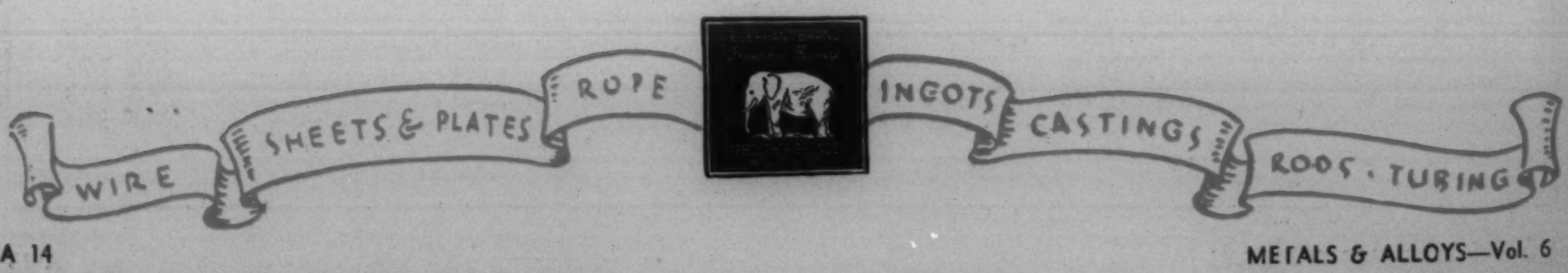


HIGHLIGHTS

Written by the Abstract Section Editors and the Editorial Staff

DO YOU want to know what metallurgical engineers are saying, the world over? Look in the Current Metallurgical Abstracts. Here are some of the points covered by authors whose articles are abstracted in this issue.

Process for Removing Sb from Bullion

Thermodynamic calculations show the theoretic soundness of a counter current method of removing Sb from bullion. A process is proposed by Maier (page MA 273 L 7).—A.H.E.

Nitrogen

A fruitful field of effort is uncovered by Eilender and Meyer in their studies of nitrogen in slags (page MA 277 L 3). Another slag-metal relationship for the metallurgist to worry about.—C.H.H.

Electric Steel

Exhaustive comparative tests by Scherer and Houdremont, Kallen and Gebhart on high-speed steel made in arc and high-frequency furnaces showed only slight differences in the characteristics of the steel made by the two processes (page MA 277 L 4). —C.H.H.

Fountain of Youth for Bearings

The Timken Roller Bearing Co. recommends rejuvenating roll neck bearings every 3 to 6 months by a bath in oil at 325-350 deg. F. (page MA 280 R 7).—O.E.H.

Another Revolutionary Heat Treatment

"Penetral Process" claimed likely to replace carburizing and nitriding. Applicable to malleable iron, some cast irons, cast and wrought steels, and most of the ferrous alloys; however, no important details are given. Technical men are likely to keep their fingers crossed on mysterious revolutionary processes (page MA 281 L 5).—O.E.H.

Black Chromium Plate

The beauty of bright chromium plating is greatly enhanced when it is used to contrast with a black background. A recent German process for the production of black chromium plating seems to offer much promise along this line (page MA 288 R 3). In the production of a sign for example, the design, preferably in raised form, can be plated with bright chromium and then the background with black chromium, or vice versa.—H.S.R.

Reduced Maintenance

Twenty per cent increase in the life of open-hearth linings by the use of new refractories developed in Germany is reported (page MA 282 L 7). —M.H.M.

Metal Spraying with Aluminum

The production of protective coatings of aluminum by conventional methods is not practicable. Metal spraying is the most convenient means for this. The use of aluminum coatings for boiler parts has many advantages and this particular use is said to be greatly increasing in German ship building practice (page MA 289 L 4). A semi-metal coating of aluminum is produced by using aluminum paint. This method, used for years in a small way, is having a try-out on a large scale for railroad trains by the Lackawanna Railroad (page MA 289 L 8). —H.S.R.

More About Flakes

The problem of flakes in steel is receiving attention in Germany. Some claim that the flake-producing villain is hydrogen (page MA 290 L 3) while others believe there is a whole gang of villians, the identity of some being still unknown (page MA 290 L 4).—C.S.B.

Nuts to You, Bolts!

In recent tests at the National Bureau of Standards (page MA 290 R 3), the impact work for bolts with SAE threads was approximately the same as for bolts of the same size and material having USS threads. Similar relations were observed for the static work and the maximum static load. For bolts of the same size and having the same threads, the bolt efficiencies were approximately the same for five different bolt materials.—W.A.T.

Atmospheric Corrosion-Fatigue

Recent experiments at the British National Physical Laboratory by Gough and Sopwith (page MA 292 L 7) have yielded interesting results as to corrosion-fatigue caused by atmospheric action. This action seems by no means negligible, especially as shown by tests of lead. Indications of such corrosion fatigue of lead were also obtained by Haigh at Greenwich, England, some time ago. Certain nonferrous metals, notably some of the aluminum alloys, develop no well-marked endurance limit when tested in air, and the British test results raise the question whether very slowly acting atmospheric corrosion-fatigue may explain this result. Fatigue tests of aluminum alloys and other nonferrous metals in vacuo would seem to be worth making.—H.F.M.

The Cooling Power of Suggestion

Metallurgical Abstracts adds a new hot-weather feature—a group of abstracts on properties of metals at very low temperatures, even in the vicinity of absolute zero (page MA 300 R 6, 7, 8, 9 and 10). Read and keep cool! And supra-conductivity and its accompanying phenomena are interesting factors that must ultimately help the metallurgist in his conception of the structure of solid metals.—L. J.

An Abstract of the Second Degree

Mehl (page MA 294 L 2) to the tune of 382 references, skims 1934's theoretical metallurgy.—J.S.M.

Phase-Diagram Bargain Day

Presented this month is an unusually large batch of diagrams—some partial, others complete: Rh-Cu (page MA 294 L 4); Pr-Au (page MA 294 L 7); Fe-Pt (page MA 294 L 9); Hg-Tl (page MA 294 R 4); Cu-Sn-Be (page MA 294 R 5); K-Rb (page MA 294 R 7); Fe-N (page MA 294 R 7); Ni-Mn (page MA 294 R 8); Al-Mg (page MA 294 R 9) and Ag-In (page MA 294 R 10). Anything wanting in quality is compensated by quantity.—J.S.M.

More Steel Dynamics

Smith (page MA 294 R 2) compares various methods of following the transformation of austenite, with some interesting results. Each method was found to be useful for certain purposes, but the microscope is most reliable for determining the amount of transformed substance.—J.S.M.

New Alloys for High Temperature Heating Elements

Nordström (page MA 299 L 2) describes new Cr-Co-Al-Fe alloys which are alleged to be serviceable at unusually high temperatures (2700-2800 deg. F.).—E.S.D.

Hydrogen Increases Scaling of Steel

A German discussion of the effect of furnace atmospheres on scaling of sheet steel (page MA 300 R 3) charges hydrogen in the fuel with responsibility for increased scaling. Thus coke as a fuel produced the minimum scaling while mineral oil, with 12 to 13 per cent hydrogen, caused the maximum scaling.—L.J.

Elasticity of Steel at High Temperatures

Short-time high temperature tensile tests have of late taken a back seat as more attention has been given to creep. Verse (page MA 300 R 4) turns attention again to elastic properties of steel up to 500 deg. C. and compares static and dynamic methods.—L. J.

High Strength Steel Sheets

V. H. Lawrence (page MA 305 L 6) presents a timely discussion on this subject. We shall hear more of high strength steel sheets.—M. G.

The Powdered Coal Motor

The powdered coal motor raises new abrasion problems for German metallurgists. Their answer (page MA 305 L 7) may help Americans to solve similar problems.—M. G.

MONEL METAL CASTINGS

Made in Three Grades, Rough or Machined, in our Enlarged and Re-equipped Foundry

MONEL METAL   2½% Si. MONEL METAL   S MONEL METAL

Grades and Composition

Monel Metal castings are made in three grades—the regular grade and two special grades, identified as 2½% Silicon Monel Metal and S Monel Metal. Typical analyses of each grade follow:

	Monel Metal	2½% Si. M.M.	S Monel Metal
Nickel	67	65	60
Copper	29	29	33
Iron	2.0	2.25	2.5
Silicon	1.25	2.75	3.75
Manganese	.75	.70	.65
Carbon	.20	.20	.10

Uses and Advantages

Used for both industrial and artistic purposes, Monel Metal castings combine high resistance to corrosion with high strength and a pleasing white color. The corrosion resistance of the metal is especially good against the common corrosives, such as salt water, caustic soda, and sulfuric acid. The two special grades are distinguished from regular Monel Metal castings by their mechanical properties, the corrosion resistance of all three grades being practically the same. The accompanying table gives the mechanical properties of Monel Metal castings as well as other cast metals.

The special S Monel Metal has a valuable non-galling characteristic that is especially useful where seizing must be avoided, as in bearings, valve trim, etc. By combining S Monel Metal with regular Monel Metal, either cast or rolled, it is possible to eliminate seizing difficulties in machinery, such as pumps, constructed entirely from Monel Metal so as to assure corrosion resistance in all parts and at the same time eliminate galvanic corrosion that may result from the use of two metals differing greatly in composition. Furthermore, by increasing the silicon content slightly, S Monel Metal castings of higher hardness (up to 390 Brinell) may be furnished for use in applications where high hardness is particularly desirable.

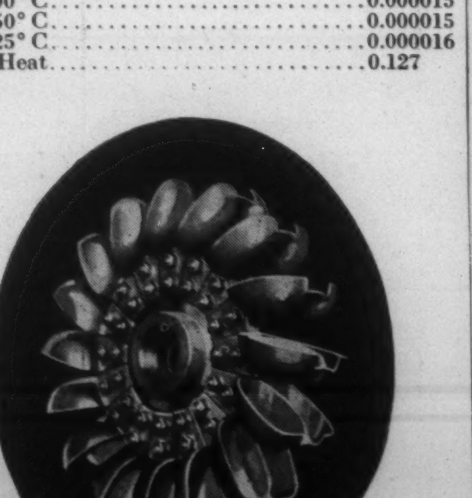
The 2½% Silicon Monel Metal has properties intermediate between Monel Metal and S Monel Metal. It combines hardness with strength and ductility to good advantage, and it does not gall under most conditions.

Magnetic Properties

Castings of 2½% Silicon Monel Metal and S Monel Metal are non-magnetic down to at least 30 degrees below zero Fahrenheit.

Physical Constants of Castings

Density	8.50 –8.80
Specific Gravity, lb. per cu. in.	0.317–0.318
Melting Point, ° F.	approx. 2400
Mean Coefficient of Expansion (S Monel Metal)	
25°–100° C.	0.000013
25°–300° C.	0.000015
25°–450° C.	0.000015
25°–525° C.	0.000016
Specific Heat	0.127



The buckets of this Pelton water wheel for an impulse turbine are of cast Monel Metal, with concave surfaces polished. The high strength, toughness, and corrosion-resistance of Monel Metal castings are all utilized to good advantage in these buckets.

Production Facilities

Sand and centrifugal castings of Monel Metal, in all three grades, are made in our foundry at Bayonne, N. J. This plant has been rebuilt recently and much new equipment added, including a large machine shop. It is now in a position to furnish machined castings at low cost. Production is subject to laboratory control. All castings, machined or plain, undergo a rigid inspection before shipment.

Local foundries throughout the country are experienced in the casting of Monel Metal. Information on moulding, melting, and casting practice will be furnished gladly to any foundry that requires it.

Available Forms and Stocks

At our Bayonne Foundry, sand castings are made weighing up to 4,000 lbs., and as large as 13 ft. in diameter. Centrifugal castings are made in lengths up to 6 ft. for diameters from 2 in. minimum inside to 8 in. maximum outside; also in lengths up to 24 in. for diameters up to 18 in. outside. These castings are made in all three grades.

A variety of fittings cast in regular Monel Metal are available from stock. These fittings are of standard cast iron design and they include couplings, elbows, tees, crosses, caps, plugs, reducing fittings, and bushings, lock nuts, ground joint unions, flanges, and plug cocks. Also, bib cocks and similar articles are stocked.

Leading manufacturers of valves and pumps supply these in Monel Metal. Information on sources of supply for such equipment will be furnished on request.

Machining Practice

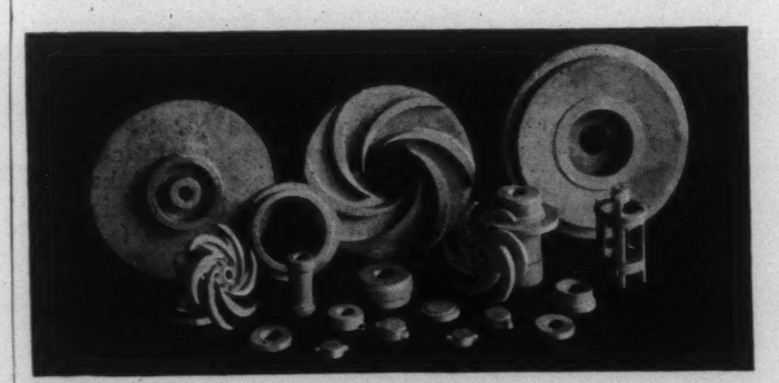
Castings of regular and 2½% silicon Monel Metal are machinable. S Monel Metal castings up to 350 Brinell hardness may be machined without difficulty. Slower cutting speeds are used and lighter cuts are taken than for iron or brass. Tools should be of tough high speed steel and larger in size than for iron or brass. The nose of the tool should be ground so as to provide good support for the cutting edge. Grind a blunt slightly rounded nose and cut down the under clearance to about 7 degrees. At the cutting edge, it is advantageous to use an almost perpendicular land (1/32" to 3/64" wide) which reduces the under clearance at that point to practically zero. The side angle and top clearance or rake may be varied to suit the work, the rake being usually about 13 degrees and the side angle about 8 degrees. Abundant lubrication is recommended. Sulfurized mineral oil is used for boring and other inside work. This lubricant is preferred for all work, though water soluble oils will suffice for ordinary lathe work. Detailed machining instructions will be furnished on request.

Silver Soldering

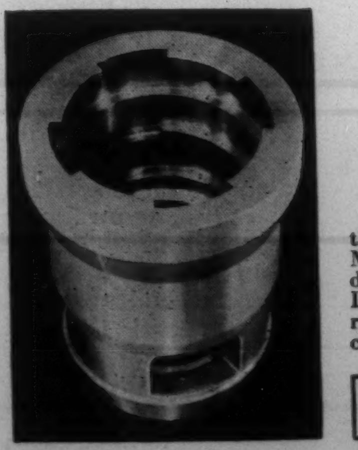
All three grades of Monel Metal castings may be joined to other parts of the same metal by silver soldering, which produces a strong corrosion-resisting joint. Easy-Flow Brazing Alloy and Handy Flux are recommended. Both are supplied by Handy and Harman, 82 Fulton Street, New York, N. Y.

MECHANICAL PROPERTIES OF CASTINGS

	Tensile Strength lbs. per sq. in.	Yield Point (0.5% Set) lbs. per sq. in.	Elongation % in 2"	Brinell Hardness (3000 Kg.)	Izod Impact (Standard Notched Bars) ft. lbs.
Monel Metal	65– 90,000	30– 50,000	20–45	120–180	65–80
2½% Silicon Monel Metal	75–100,000	40– 60,000	8–15	175–225	35–45
"S" Monel Metal	100–125,000	....	......	275–390	very low
Red Brass (Cu 85; Pb 5; Sn 5; Zn 5)	27– 33,000	15– 19,000	16–20	50– 60	10–15
Gray Cast Iron (TC 3.10–3.40; Si 1.80–2.30; Ni none)	25– 30,000	....	.....	160–190	.7– .9
Nickel Cast Iron (TC 3.10–3.40; Si 1.40–1.80; Ni 1-2)	30– 40,000	....	.....	180–220	1.3–1.8
High Test Alloy Cast Iron (TC 2.90–3.30; Si 1.40–1.80; Ni 1–2)	40– 50,000	....	.....	180–240	1.5–2.0
Ni-Tensyliron (TC 2.60–3.10; Si 1.10–1.80; Ni 1–3)	50– 65,000	....	.....	190–250	1.8–3.0



(Above)
Monel Metal castings as frequently used by manufacturers of centrifugal pumps handling corrosive liquids, such as salt water and caustic soda.



This valve part, used in steam turbine service, was cast centrifugally from S Monel Metal and machined. Castings of S Monel Metal are strong, hard, and non-galling.

Decorative water fountain made of Monel Metal for the S. S. "Bremen." The nozzles and portions of the heads are of cast Monel Metal, which are joined to other parts fabricated from Monel Metal sheet.

Literature

Technical bulletins and other literature giving further information on the properties of rolled and cast Monel Metal are available on request. These include detailed instruction for silver soldering, etc. Send for List B showing all literature on Monel Metal and rolled nickel. If interested also in nickel steels, nickel cast iron, nickel bronzes, etc., ask for List A as well.

Copies of this page are available in loose-leaf form. Send for yours.

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The Editorial Advisory Board

OUT of the fullness of their experience, the members of the Editorial Advisory Board,—leaders in metallurgical research and in its application to practical metallurgical engineering,—are notably qualified to guide the editorial staff in the selection of material for publication. Few, indeed, are the phases of metallurgy in which these men cannot authoritatively appraise what is worthy of record and of study in current progress and that which foreshadows future advances.

Service on this Board is not perfunctory, it is real. It demands the time of busy men, time gladly given because they believe that through the medium of Metals & Alloys, they are helping to advance the science and practice of metallurgy.

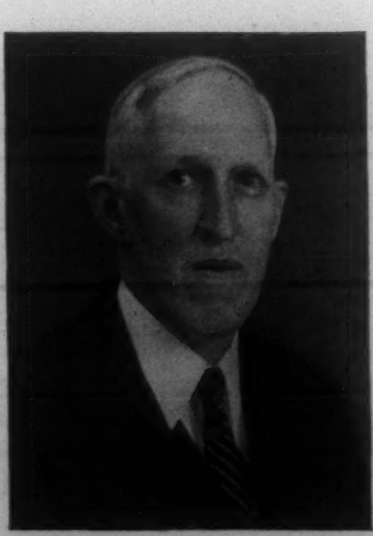
The editorial staff has a deep appreciation of the aid and counsel of the Board. Much that the readers give the editorial staff credit for is traceable to the suggestions, constructive criticisms, and kindly advice of the Board. The authors perhaps know better than the readers how real and how helpful the Board's counsel is, for many of them have improved their articles materially on the basis of suggestions made by Board members who have criticized the first drafts of the articles.

Knowing that the readers will be glad to get better acquainted with these men who, unobtrusively but effectively, do so much toward the continued betterment of Metals & Alloys, we are publishing photographs, and brief sketches of the careers, of the Board in this and subsequent issues.—H.W.G.

HARVEY A. ANDERSON is head of the meallurgical development work in connection with the manufacture of telephone equipment at the Hawthorne Works of the Western Electric Co., Chicago. He was graduated from Northwestern University in 1915 with the degree of B.S. At the end of a post-graduate year in the Engineering College of the same university, he received the degree of C.E., specializing on materials of construction. During the next five years, 1916 to 1921, he was an engineer on rails, ties and timbers for the So. Pac. Ry., on materials engineering work at the Bureau of Standards, and as engineer of tests for the Naval Aircraft Factory, Philadelphia. He joined the staff of the Bell Telephone Laboratories in New York in 1921. At first he was connected with the establishment of physical test methods for telephone apparatus materials and later in metallographic and metallurgical studies. In 1930 he was transferred to his present position. He has been and still is very active in technical societies, including the A.S.T.M. and its committees, the A.S.M. as chairman of the Chicago chapter (1934-1935) and the A.I.M.E. He is the author of several technical papers.

Harvey A. Anderson

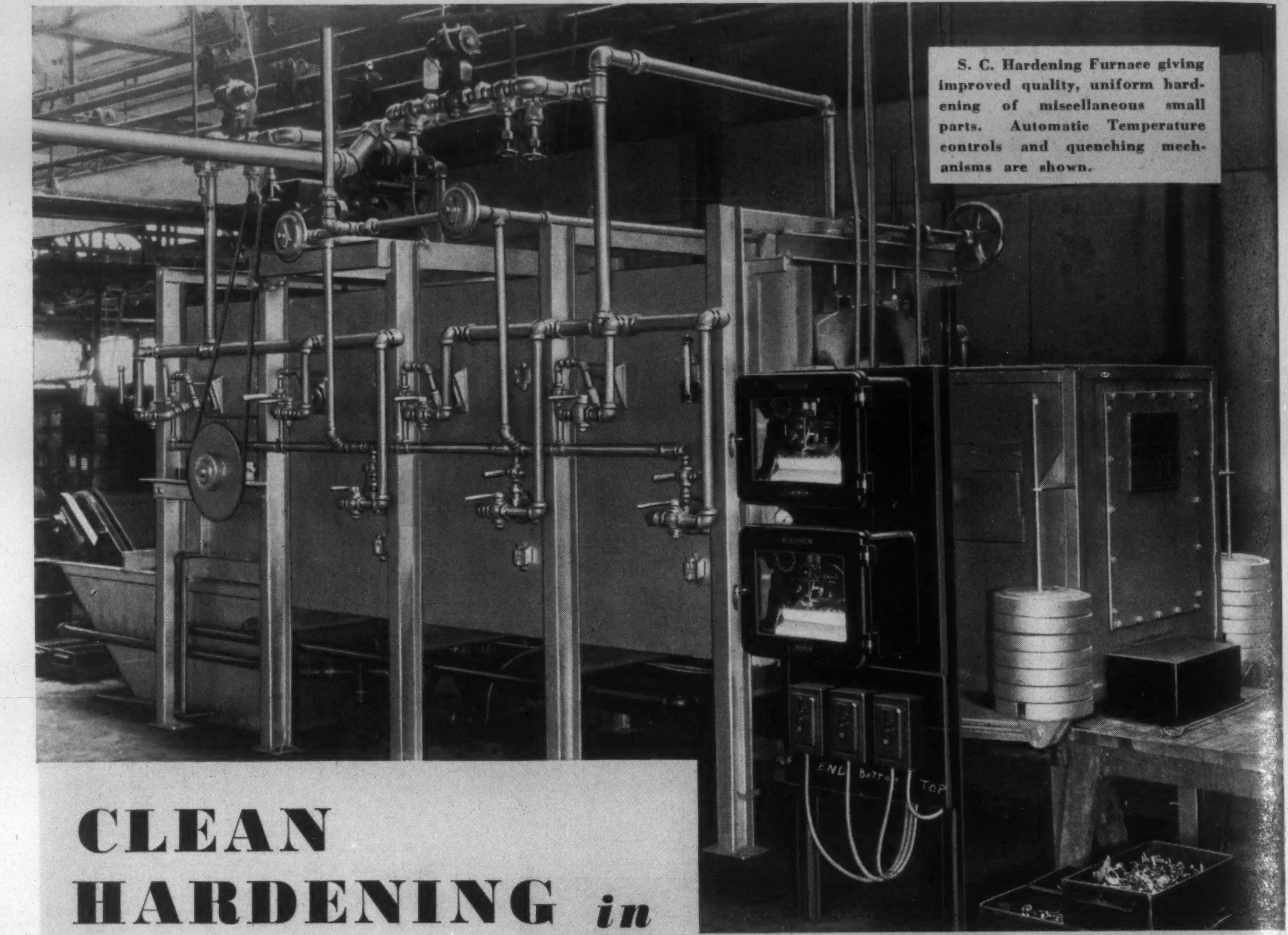
WILLIAM BLUM for the past fifteen years has been in charge of studies on electrodeposition at the Bureau of Standards, Washington, with special reference to the electroplating and electrotyping industries. He has been at the Bureau since 1909, at first as a chemist in researches on analytical methods. He was born in Philadelphia in 1881 and was educated at the University of Pennsylvania, where he received his B.S. degree in 1903 and a Ph.D. in 1908. He was an instructor in chemistry in the University of Utah for five years.



William Blum

Recently Dr. Blum returned from a trip of about six weeks, during which he visited about 50 plants and laboratories in England, France and Germany. He also attended meetings of the Faraday Society and the Electrodepositors' Technical Society in England.

Dr. Blum has contributed many articles and papers in his chosen subject, and is a joint author with G. B. Hogaboom of a text book, "Principles of Electroplating and Electroforming." He is a member of the A.C.S., The Electrochemical Society and the A.S.T.M.



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EDITORIAL COMMENT

Instruction in Corrosion

A MEMBER of our Editorial Advisory Board recently remarked that of all the dumb mistakes engineers make, about the dumbest are those arising from ignorance of corrosion problems. The misuse of materials and the failure to utilize known protective measures which he had noted among supposedly well-grounded engineers made him feel that they probably lacked an adequate introduction to corrosion matters in college days. He suggested that it would be interesting to find out what was being done along this line in some of the engineering schools. He further suggested that it would be a good measure of self-protection against misuse of materials for the makers of alloys to provide visiting lecturers who would give the budding engineers some pointers on the practical applications, possibilities and limitations of the alloys they produce.

Inquiries to several schools show that separate courses on corrosion appear in the curricula in but few cases. Incidental comment on corrosion seems to be scattered through most courses on materials of construction and in those on inorganic chemistry and chemical engineering, ordinarily with much more emphasis placed on it in chemical engineering than in mechanical engineering.

At M.I.T. there is a graduate course in corrosion, two hours a week for one term, attended by twenty to forty, chiefly chemical engineers, though others with adequate preparation are admitted. Graduate seminars on corrosion, with outside speakers, have been held from time to time.

At Columbia there is a course of three lectures a week for one term in the Department of Chemical Engineering given by the staff, which is optional for all engineering students.

At Carnegie Tech, a special course on corrosion used to be given to graduate students in metallurgy, but was later transferred to night school, though open to both day and night students. It was made an advanced undergraduate course, optional for graduates. Speller's book was used as text. There is some question whether the course will be given in 1935-1936.

At Cornell, all chemical engineers and all candidates for the degree of Bachelor of Chemistry take a chemical engineering course in which ten lectures deal with corrosion directly and several others, on materials for chemical construction, do so indirectly. A course in chemical plant design is also given which considers the corrosion aspects. The chemists also take the course on materials of construction given in the mechanical engineering department, as, of course, do the M.E.'s, and this includes several lectures dealing with corrosion theory and some specific applications.

At Yale, corrosion is dealt with in the courses on general and physical chemistry.

Some of the professors question whether anything more than superficial instruction in corrosion can be given until the students have had a good deal of physical chemistry. With such prerequisites, the M.E.'s are not likely to have a chance to take the special corrosion courses. We wonder whether it wouldn't be a good thing to expose the M.E.'s to a fairly complete discussion of corrosion just the same. Once upon a time we had to run lab sections in a short course in toxicology given in the chemical department, but taken only by medics. We had never had any toxicology and had to keep humping to keep ahead of the class. Fearing that the instruction we were giving was pretty rotten, we conscientiously so told the professor in charge. He replied, "This course isn't to teach toxicology, it is to impress these medics that, when they get up against a toxicological problem, they should call in an expert and not monkey with it themselves." It would be worth while to impress the engineer having to do with materials that many corrosion problems are extremely complex and not to be handled on the basis of snap judgment, but rather by consultation with those who have a special background of experience in such lines.

The reactions of the professors to the idea of outside lecturers were interesting. In general, they would welcome speakers who can get down to brass tacks and really inform the students, but on the whole, they note a tendency on the part of outside lecturers to thresh old straw and spend too much of the time in dealing with the theories which the professor has already covered. A tendency to try to make a hit with the students by telling stories, failure to talk to the students instead of the blackboard, etc., are cited as reasons why the average outside lecturer does not get his message across well.

Obviously if outside lecturers are to be utilized successfully, the professor should give the lecturer a very definite idea of the state of preparation and the maturity of the students to whom he will talk, and see to it that the visitor prepares a special talk suited to his audience rather than merely bringing a few slides and making rambling, off hand, comments. On the other hand, if the lecturer could deal with examples from his own engineering practice of proper applications and misapplications of materials, it would be helpful.

Prof. Mathewson remarks that, if some of the leaders in the practical prevention of corrosion could stay for a week and give a series of talks, something worth while might be accomplished. Failing that, he thinks the solution is to get the right kind of people to write the right kind of books.

Personally, we think one trouble is that the mechanical engineer in particular, and to a lesser extent the metallurgical engineer, is too prone to be content with a four-year course and not to supplement his undergraduate training with at least one year of graduate study. (Incidentally, we would prefer to have the student come back for this graduate year, rather than to

(Continued on page 174)

From a Drawing by Charles Perry Weiner, New York

COPPER STOOLS FOR INGOT MOLDS—I

By CLYDE E. WILLIAMS AND H. B. KINNEAR

Director and Metallurgical Engineer, respectively, Battelle Memorial Institute, Columbus, Ohio.

Acknowledgments

THIS WORK WAS initially sponsored by the Copper & Brass Research Association and was aided by the individual work of several of the member companies, more particularly by the U. S. Metals Refining Co., and the Calumet & Hecla Copper Co. The work is now sponsored by the U. S. Metals Refining Co. Special acknowledgment is made to C. H. Aldrich and D. L. Ogden of the U. S. Metals Refining Co., for their assistance.

Much of the experimental work has been carried out under conditions of commercial operation in several steel plants. Without the cooperation of many individuals of the steel companies, the work could not have been brought to its present state of development. Special acknowledgment is made to T. F. McNally, Jack Cameron, J. W. Alden and Earl Smith of the Republic Steel Corp., H. P. Gaw and L. F. Reinartz of the American Rolling Mill Co., and H. B. Hubbard and J. Hunter Nead of the Inland Steel Co.

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ON THE ASSUMPTION that the high thermal conductivity of copper would permit its use as molds for casting steel ingots and would cause sufficiently rapid cooling of the steel to improve the ingot surface and to effect the formation of a finer grain structure, laboratory experiments were made, casting 50 to 300-lb. ingots. These tests showed that steel could be poured into a copper mold without damage to the mold, that the ingot surface was better, and that a finer grain structure was formed, but only to a small depth. The rapid cooling effect only lasted for a short period of time, owing to the formation of an air gap between the ingot and the mold due to the contraction of the steel ingot.

Since satisfactory experimental work required large-scale tests, it was necessary to conduct the research investigation in steel plants on a large scale. Thus far, the work has been concentrated on the use of stools, inserts and mold plugs. Over 500,000 lb. of copper stools for ingot molds are now being used by the steel industry. Fig. 1 shows a drag of 24 in. x 24 in. molds on copper stools.

On first thought, one might not suppose that a material with a melting point so much below that of the

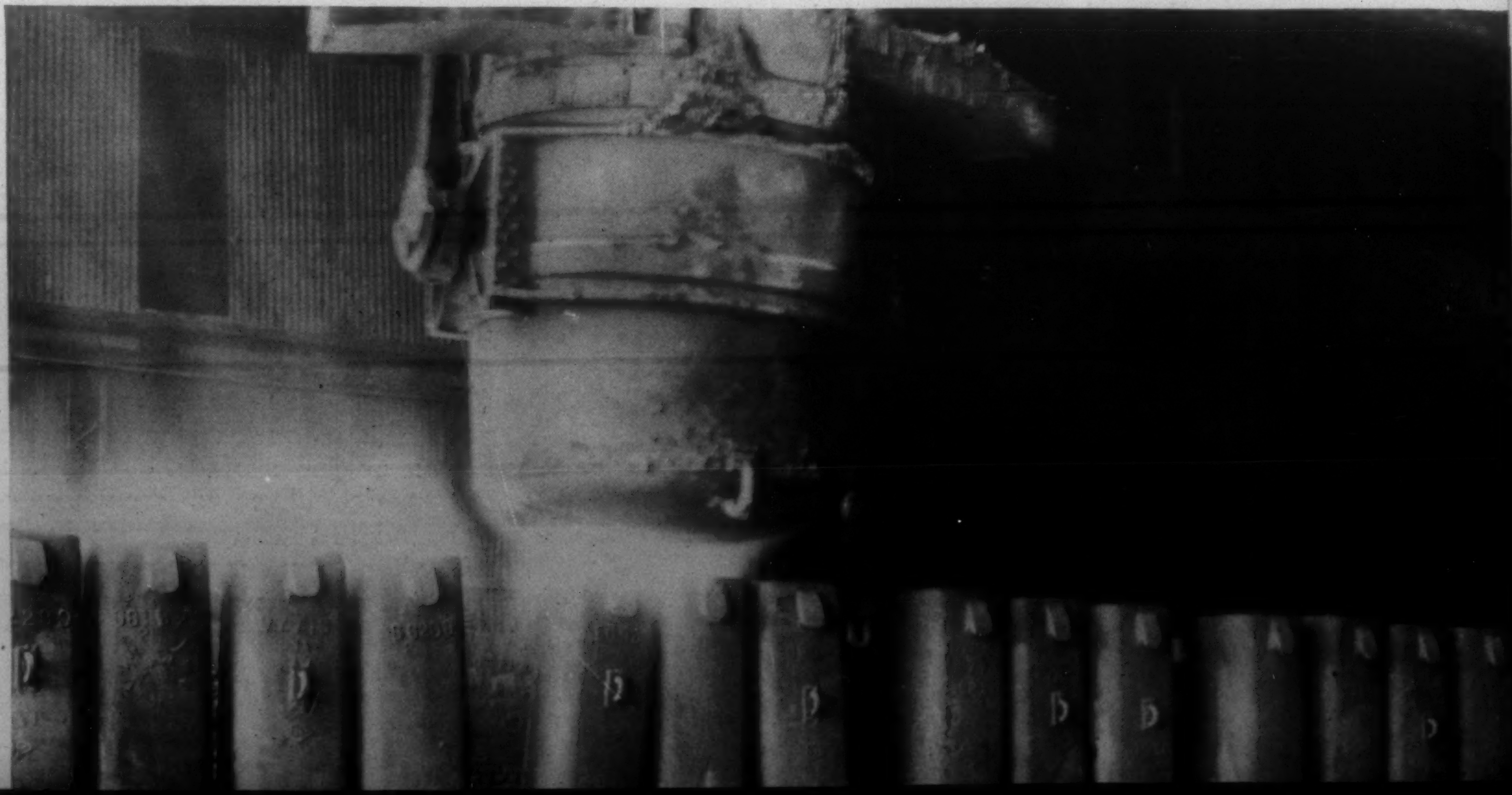


Fig. 1. A Drag of Molds on Copper Stools.

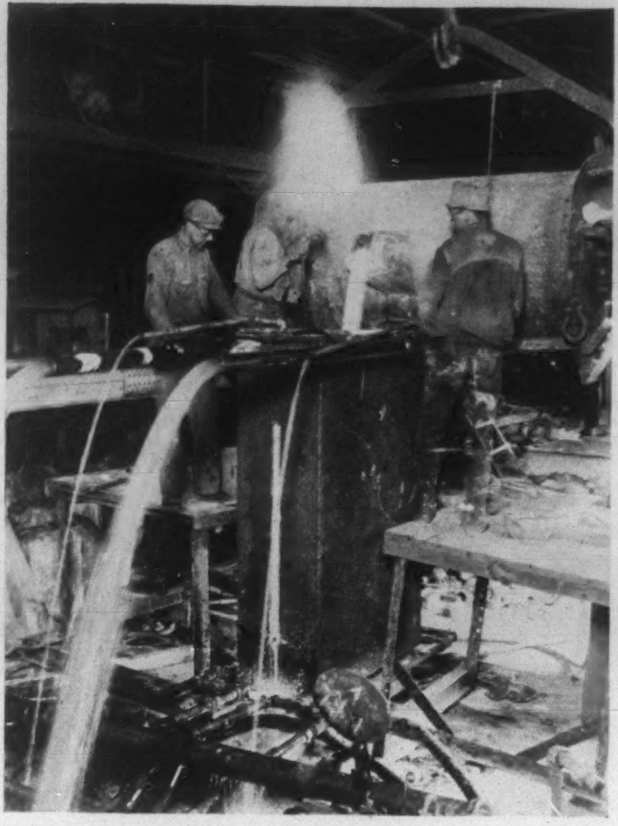


Fig. 2 Pouring a Copper Cake in a Water-Cooled Mold.

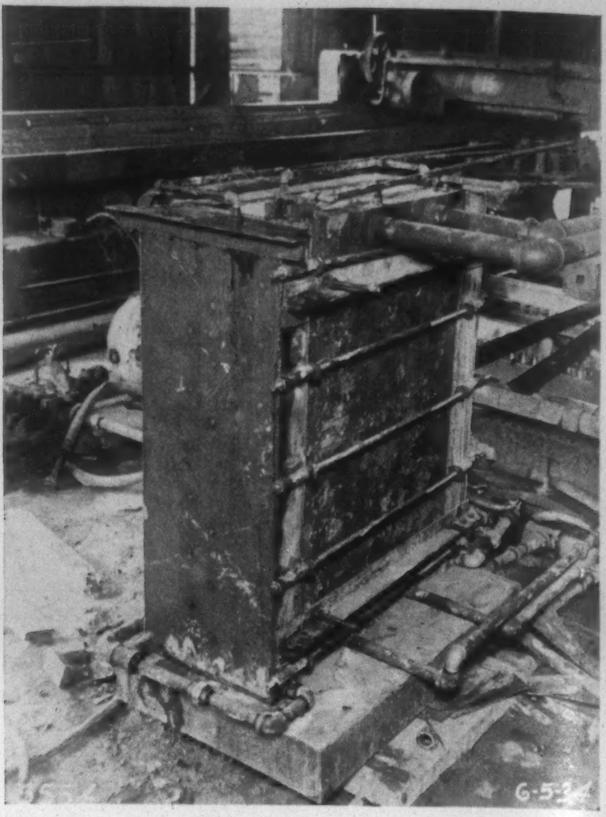


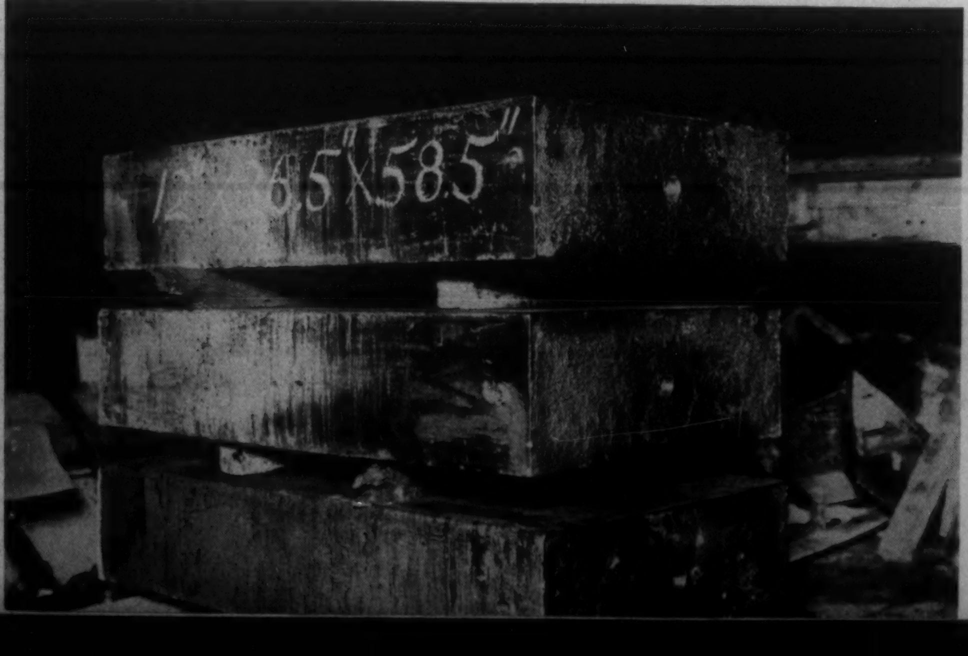
Fig. 3. View of the Water-Cooled Mold.

steel poured upon it would be suitable for this service. The melting point of copper is about 850 deg. F. below the pouring temperature of steel and is about 150 deg. F. below that of the iron used in molds and stools, but the thermal conductivity of copper is nine to ten times that of cast iron. This greater thermal conductivity offsets the lower melting temperature through rapid heat conduction, in consequence of which the surface of a copper stool in contact with the liquid or partially solidified steel is considerably cooler than the surface of a cast iron stool.

As an example, comparative temperature readings taken at the top surfaces near the center line of a copper and a cast iron stool showed the surface temperatures after the first impingement of the metal stream to be about 800 deg. F. lower in the copper stool. After this initial, almost instantaneous rise in temperature, which occurred during the first few seconds that the ingots were being poured, the surface temperatures of the stools never again attained these maximum values. This naturally explains the resistance of copper stools to cutting by molten steel.

The average life of ordinary cast iron stools is appreciably less than 100 heats and, long before they are discarded, the stools are badly cut out and deeply cracked where the metal stream first strikes. This accounts for bulged ingot butts and for difficulties in stripping the mold. With properly designed high-conductivity copper stools, this erosion rarely takes place, due to the rapidity with which the heat is withdrawn from the stool face, and not only is the life of the stool thereby greatly extended but the contour of the ingot butt remains flat and difficulties in stripping are avoided. Also, the temperature of the steel in the lower section of the mold falls more rapidly, due to the higher thermal conductivity of the copper stool, and the mold life is materially lengthened. These advantages justify the initial cost of the copper stool and make its use economical.

Fig. 4. Three Copper Stools, 36½ by 58½ by 12 in., Cast in Water-Cooled Molds.



Method of Casting

Copper stools may be cast in sand molds, in open molds, or in vertical water-cooled molds, in the form of "cakes" of the required size. Cakes cast in the latter molds are characterized by smooth surfaces which require no machining before being placed in service. Figs. 2 to 5 show the process of casting in water-cooled molds and the product so obtained.

Type of Copper Used

Most of the copper used in industry today is "tough-pitch," with an oxygen content of approximately 0.04 per cent. This type of copper may be cast into a variety of shapes and is used almost exclusively in the production of copper sheets, rods, wire and other products requiring ductility combined with high conductivity.

The presence of oxygen serves a useful purpose in that shrinkage is counteracted by gas evolution on solidification, making it possible to cast shapes with "flat set" in open molds. Most of the copper stools used in mill tests have been made from this type of metal, cast in water-cooled molds. However, more recently a few stools have been made from high-conductivity deoxidized copper and these have given excellent service.

"Tough-pitch" copper can not easily be cast into sand molds without formation of blow-holes or spongy areas near the surface. Also it is difficult to cast ordinary deoxidized copper whose conductivity is held to around 100 per cent in sand molds with assurance of freedom from surface or submerged holes or spongy areas. Some plants with special practice or by the use of special deoxidizers can do this, but in the usual foundry so much deoxidizer must be used that the conductivity is reduced to the point where the stool will fail by cutting.

High-conductivity copper is essential for satisfactory results. We recommend that for safety the conductivity be held to 90 per cent or above, although work has shown that as low as 75 per cent may be satisfactory.

The above statements refer to electrical rather than thermal conductivity, since thermal conductivity is more difficult to determine. The two are usually found to be proportional, so evaluation on the basis of electrical conductivity is sufficiently accurate.

Design of Stool

Copper is used as a stool material because of its ability to conduct heat from the molten steel rapidly. To avoid overheating the surface of the stool, however, it is necessary to have a large volume of copper present and for this reason the dimensions of the stool, particularly the thickness, become important. Ordinarily a larger ratio of copper to steel is required than of iron to steel. It is more effective to get increased weight through increasing the thickness than the cross-sectional area, which need not be much larger than the mold base.

Experience indicates that the weight of the stool should be at least two-thirds that of the ingot cast, if cutting and cracking of the stool are to be avoided. For assurance of sufficient thickness, a minimum ratio of ingot bottom area to thickness of stool should be adopted. Experience thus far indicates that both cutting and cracking of the copper stool are avoided if this ratio is below 55:1. For rectangular ingots of similar cross-sectional area, the thickness should be greater than for square ingots to avoid cracking. Copper stools, 10 to 12 in. thick, have proved satisfactory for ingots ranging from 20 by 20 in. to 30 by 30 in. in cross section. Larger ingots require thicker stools.

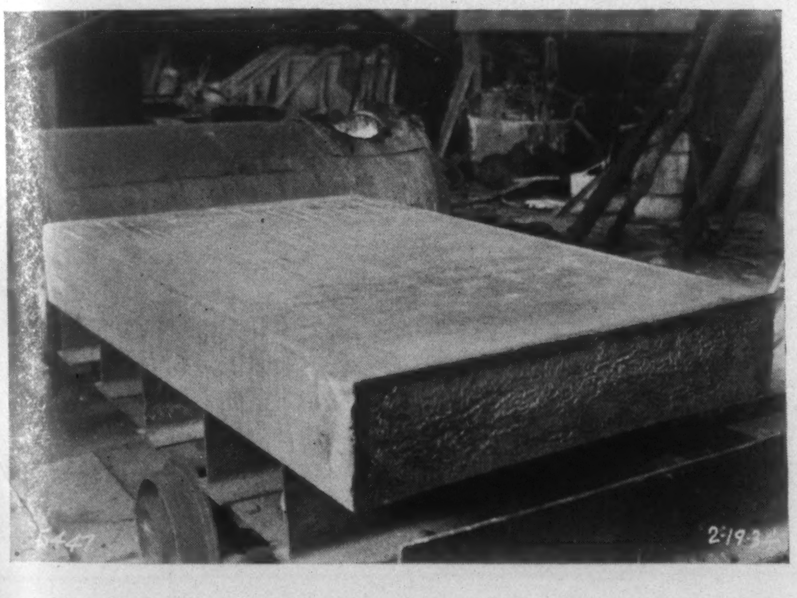


Fig. 5. Copper Stool Showing the Smooth Surface Obtained by Casting in a Water-Cooled Mold.

Most of the work has been done with low-carbon steel. Satisfactory results have been obtained in some plants with high-carbon, silicon, and alloy steels, although there have been instances of cutting of a stool by high-carbon and alloy steels where the thickness of the stool has been below that recommended above or where the force of impingement of the molten steel on the stool has been exceptionally high, owing to a high head of metal or a nozzle of small diameter. These steels have a wide solidification range as compared to low-carbon steel and it is obvious that thicker stools would absorb more heat and thus speed up the rate of freezing of the steel in contact with copper.

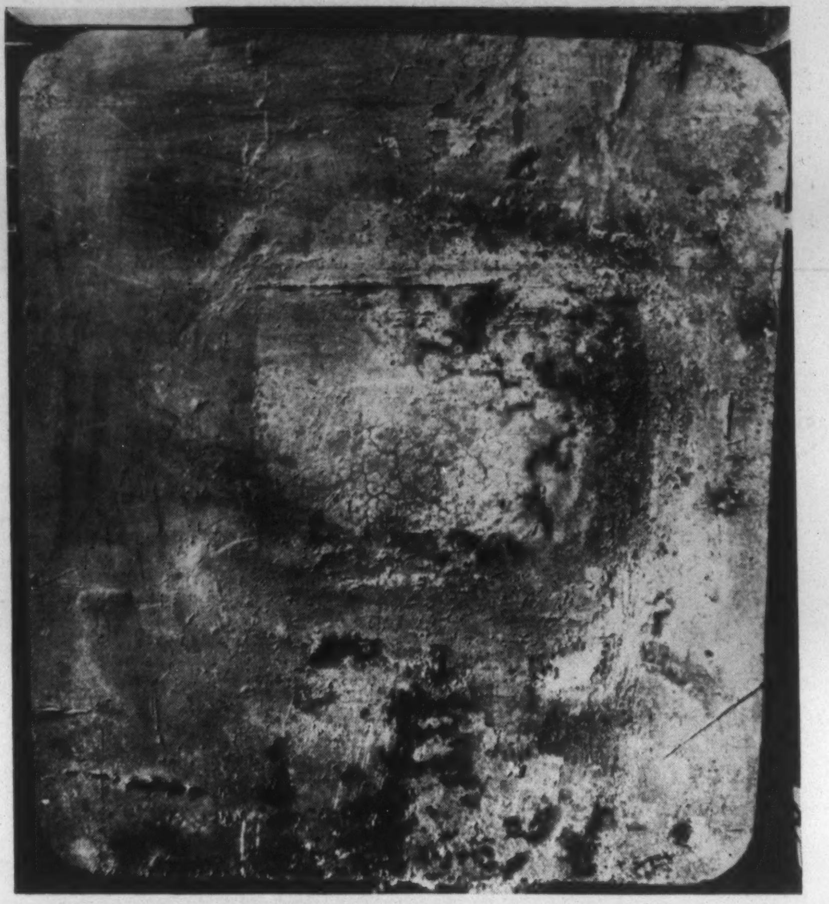
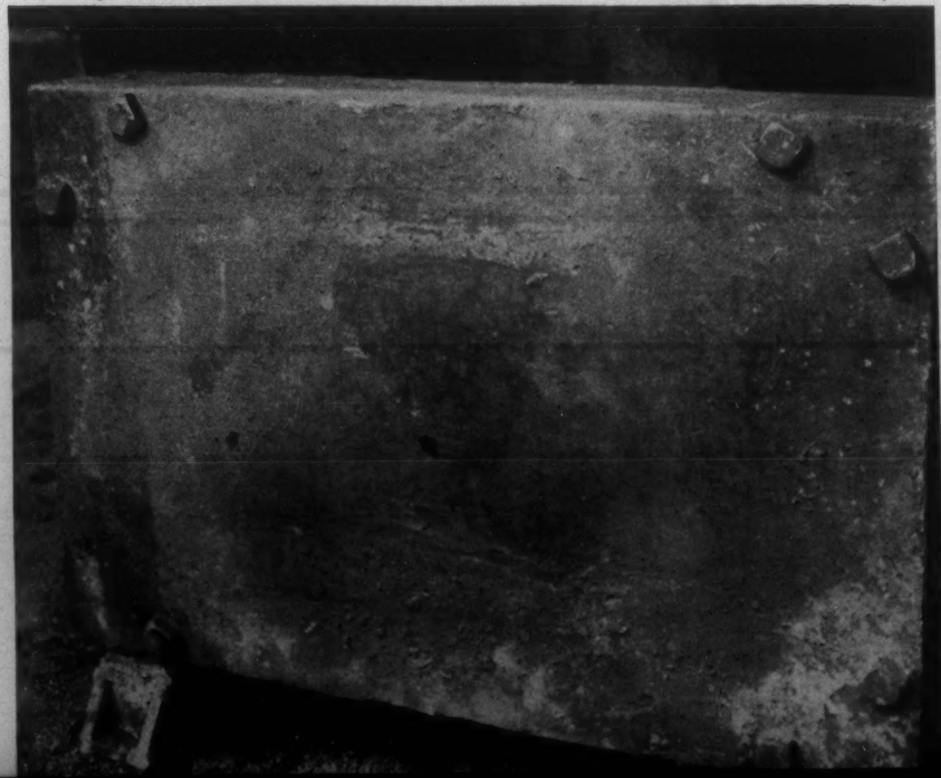


Fig. 6. Thermal Cracks on a 50 by 60 by 8 in. Stool After 80 Heats. Such cracks may well be peened at this stage.

Copper stools develop hair-line thermal cracks which gradually grow until fairly deep cracks are formed. Formation of these deep cracks can be postponed by frequent peening of the small cracks as fast as they form. Fig. 6 shows a copper stool after 80 heats.

Because copper stools are not cut by the molten steel and thus retain their surface contour, they may be dished to give a predetermined contour to the ingot butt, thus reducing the bottom crop as well as cold-shuts due to splashing. It is possible that a small dished area has some restraining influence on the tendency of the metal stream to cut the stool surface by immediately supplying a small pool of molten metal to absorb the impact of the metal stream. Practically all of the copper stools in service to date, however, are of the flat-surface type.

Fig. 7. Flat Copper Stool for 18 by 39 in. Ingot Showing Bolts for Mold Guides.



Laminated Stool

To facilitate the use of copper stools on both sides, flat cakes are used, whereas it is common practice to make cast iron stools with a pad on the bottom and lugs at the corner to guide the mold. Steel bolts placed on the copper stool, as illustrated in Fig. 7, serve as mold guides and plants that have used flat stools have experienced no difficulties due to the absence of the pad.

A recent development that gives promise of increasing the life of copper stools is the laminated stool. This stool is in successful use at one plant. It consists of a cast iron frame in which cakes of copper are held vertically by a spring at one end. These cakes are 10 to 15 in. long depending upon the thickness of stool desired, 4 in. thick and of varying lengths, depending upon the width of the stool. Individual cakes may extend the entire width of the stool or they may be shorter and staggered as brick are laid in a wall. As many such cakes are used as needed to fill up the cast iron frame. This type of stool is shown in Fig. 8.

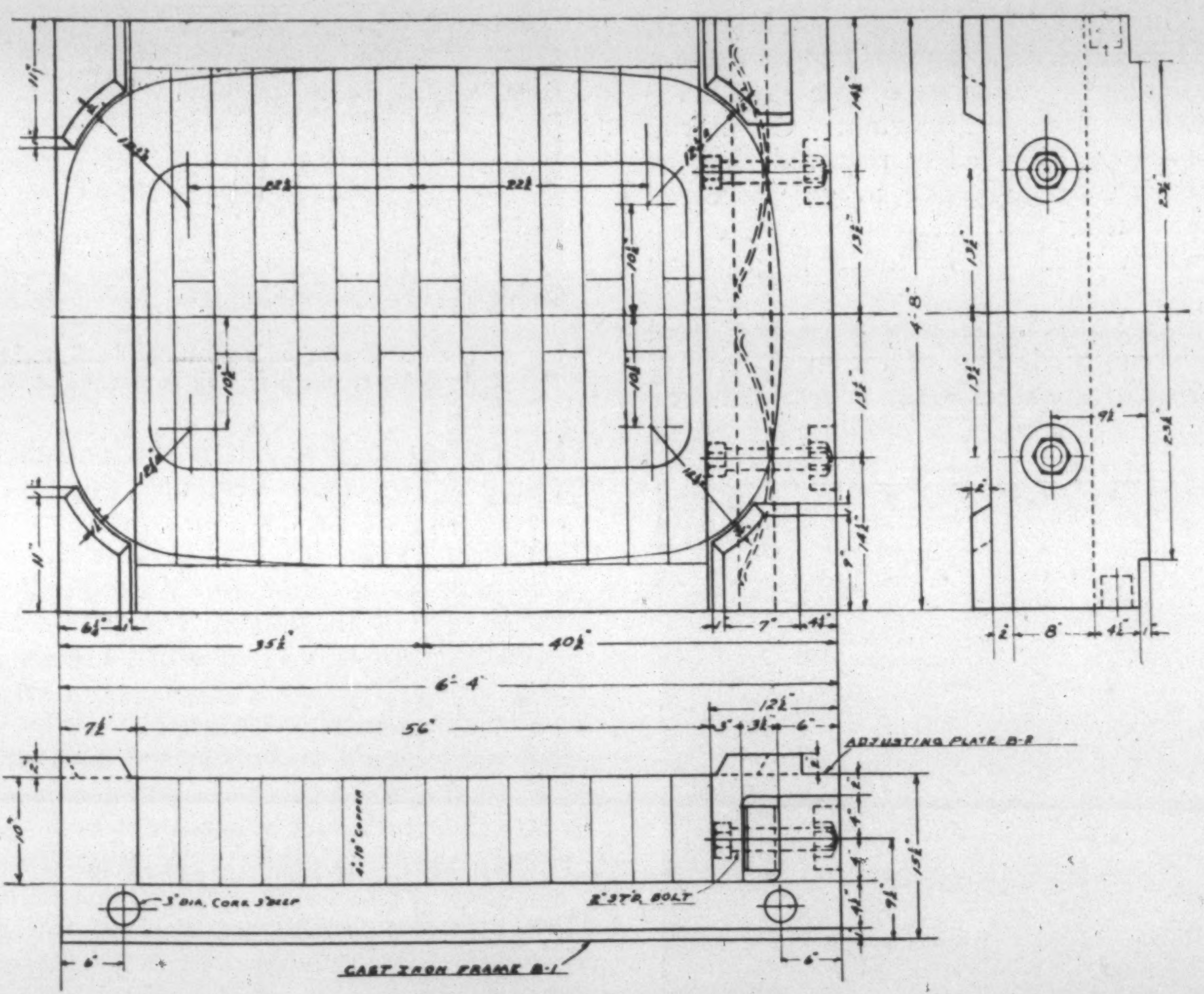


Fig. 8. Laminated Copper Stool.

Massive copper stools usually fail by the growth of hair-line cracks to such size that the liquid steel penetrates deeply enough to cause sticking of the ingot. This zone represents only a small part of the total area of the stool surface but makes the stool unfit for further use on this side. The laminated stool possesses the advantage that the few cakes of copper that are in the affected area may be replaced by new cakes, thus reducing the scrap copper to a small percentage of the weight represented by the entire massive stool.

Occasional stool failures are caused by the formation of a large crack across the center of the stool, especially in stools used with rectangular-shaped molds, the crack forming along the short axis. This crack formation is caused by the extreme stresses resulting from the heavy weight of steel ingot and mold during the period when the stool is being heated and when the copper is in a weakened state. The individual copper cakes making up the laminated stool are not subjected to these stresses as they are free to move. Thus, the laminated stool should minimize stool failures from this cause.

The laminated stool possesses the further advantage that the copper cakes can be more easily handled than the massive stool, which would require breaking up for use in the open-hearth or in the brass foundry.

Copper Inserts

Inserts made of copper have been used with success in cast iron stools and in closed-bottom molds. Copper has the advantage over iron for this use in that its surface contour remains constant because of absence of cutting and quicker cooling of the steel is achieved. The life of the copper insert is less than that of a stool made entirely of copper because of the smaller mass of copper. This, however, is compensated for by the resulting smaller amount of copper scrapped.

(To be concluded)

FUSIBLE ALLOYS—The Quintenary Eutectic of In, Bi, Pb, Sn and Cd

An Extended Abstract

IN two papers* presented to the American Chemical Society in April, 1935, Professor French describes work at Colgate University on the quaternary eutectic of Bi, Pb, Sn and Cd. While the nomenclature in the literature is not consistent, an alloy of Bi 50, Pb 27, Sn 13, and Cd 10 per cent is usually termed "Lipowitz Alloy" and one of Bi 50, Pb 25 and Sn and Cd each 12½ per cent is usually called "Wood's Metal." Different authorities give melting points for each ranging from 60 to 75 deg. C.

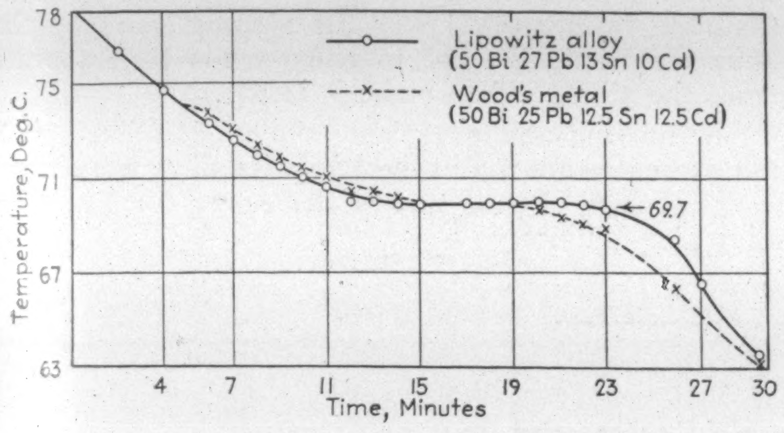


Fig. 1.—Cooling Curves, Lipowitz Alloy and Wood's Metal.

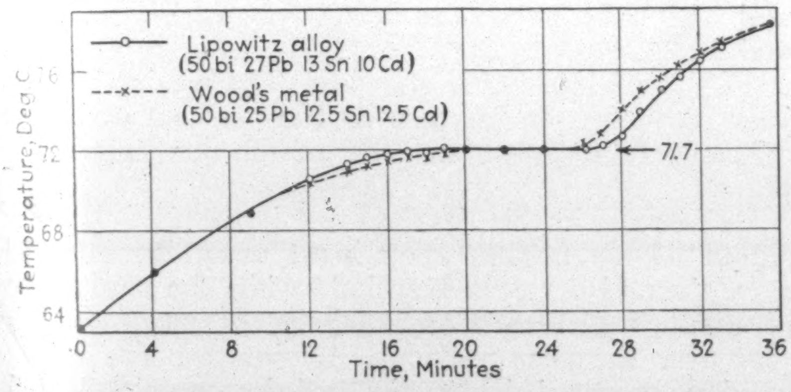


Fig. 2.—Melting Curves, Lipowitz Alloy and Wood's Metal.

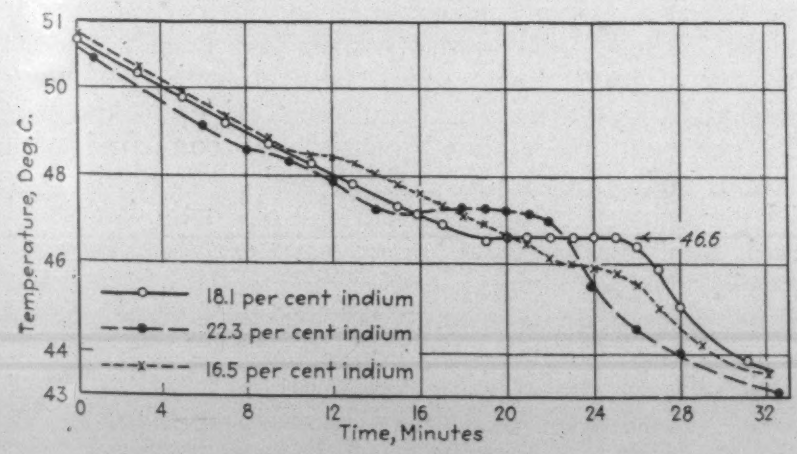


Fig. 3.—Cooling Curves, Indium-Lipowitz Alloys.

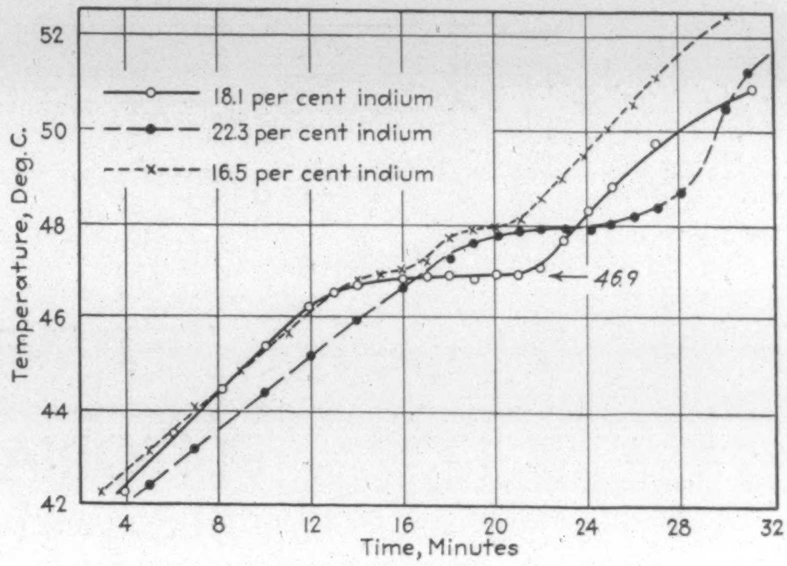


Fig. 4.—Melting Curves, Indium-Lipowitz Alloys.

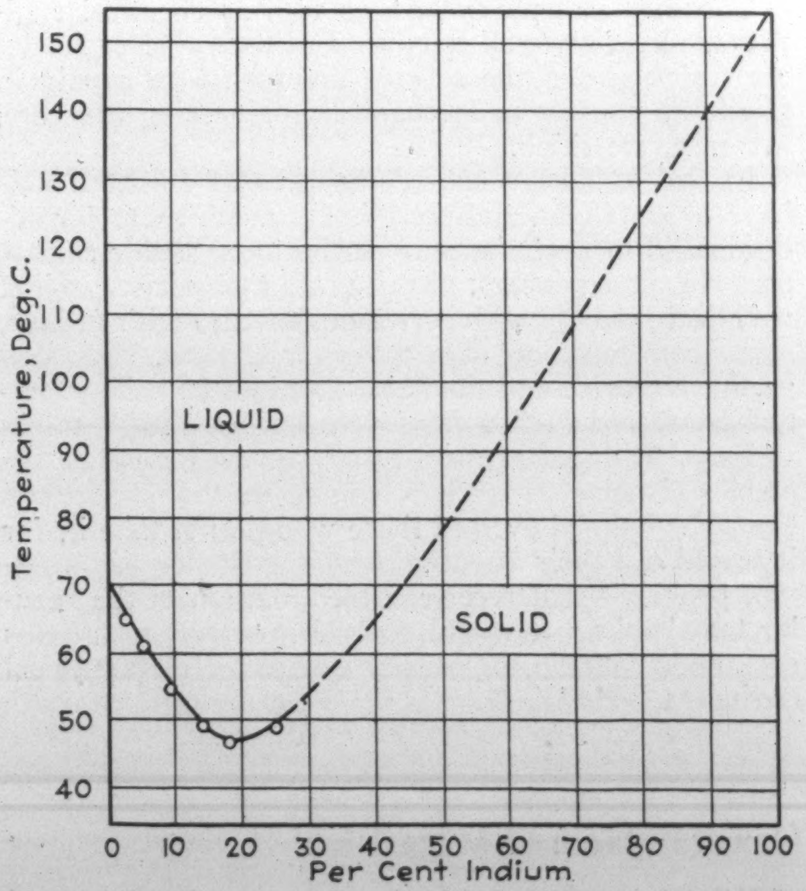


Fig. 5.—Melting Point Composition Curve, Indium-Lipowitz Alloys.

Heating and cooling curves taken by French, and shown in Figs. 1 and 2, show the same eutectic temperature for both alloys, and that both undercool. The Lipowitz composition, as the curves indicate, more nearly approaches the quaternary eutectic than does that given for Wood's Metal.

In unstirred melts, undercooling occurred, temperatures as low as 65 deg. C. being thus obtained, and even with vigorous stirring, the freezing point was 2 deg. lower than the melting point. The eutectic temperature on melting was found to be 71.7 deg. C.

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* French, S. J. "On the Melting Points of Lipowitz Alloy and Wood's Metal."

French, S. J. "A New Low-Melting Alloy."

By the addition of Hg, the melting point can be slightly reduced. With 6 to 8 per cent Hg, without stirring, the alloy may undercool to about 60 deg. C.

Table of Some Alloys of Indium with Bismuth, Lead, Tin, and Cadmium.

Percentage composition					Approximate melting point, deg. C.
In	Bi	Pb	Sn	Cd	
70	30	...	...	...	82.5
50	50	...	...	...	88.0
47.1	47.1	5.8	...	...	82.0
43.5	43.5	13.0	...	...	77.0
40.8	40.8	18.3	...	...	76.0
38.6	38.6	17.4	5.6	...	68.5
36.4	36.4	16.4	10.8	...	63.5
34.8	34.8	15.5	10.4	4.4	50.0
22.4	45.	15.7	9.5	7.5	51.0
12.6	51.	15.2	10.8	10.5	51.5
11.6	47.	19.3	11.7	9.7	51.5
9.43	57.1	16.1	9.5	7.8	52.0
8.6	52.2	23.4	8.6	7.2	53.0
8.3	50.0	22.4	12.5	6.9	55.0
8.0	48.4	21.7	12.1	9.9	55.5

Using the Lipowitz Alloy as a base the effect of possible additions is considered. Mercury tends to make the alloy extremely brittle. Save for the price, gallium might serve. Thallium does not alloy well with the eutectic, though around 10 per cent it lowers the freezing point some 4 deg. C.

Indium, now obtainable for about $2.50 to $5.00 per ounce, lowers the melting point appreciably. An alloy of about 18 per cent Indium, i.e., one containing approximately 41 Bi, 221 Pb, 10.6 Sn, 8.2 Cd, and 18.1 per cent. In, melts and freezes between 46.5 and 47 deg. C. (around 116 deg. F.) as shown by Figs. 3 and 4. This is not far above body temperature. Sharp finger prints can be obtained by dipping the finger into the molten alloy and letting the alloy freeze. Enveloped in a cloth casing, or impregnated in cloth, it could be used for surgical casts. Application of a hot water bottle to the cast would melt it.

The alloy resembles Lipowitz Alloy in malleability and ductility and has a high luster. Small amounts of thallium or mercury lower the melting point of the quintenary eutectic, but mercury tends to evaporate from the alloy, and to make it brittle.

The melting points of some alloys of Indium, with the elements entering in the Lipowitz alloy, are shown in the Table. Fig. 5 shows the curve for Lipowitz alloy plus Indium.

EDITORIAL COMMENT

(Continued from page A-19)

add a fifth consecutive year without an interim in industry.)

Chemists and physicians, as well as chemical engineers, are pretty well convinced of the value of graduate training, and the schools are set up to supply it. Graduate courses in mechanical engineering are rare, too rare, we think.

In the four-year course the present fundamentals have to be taught, and there is not much room for additions. But a graduate or an optional senior course, open to all engineers, chemists and physicists, might well deal not only with corrosion, but also with fatigue, stress concentration (key ways etc.), wear, high temperature service and the like. It might be called "materials of construction for severe service," and it might well deal with refractories as well as with metals. The mere existence of such a course in the curriculum would be helpful even to those who do not take it, for it would call their attention to the existence of important problems that receive scant attention in the regular text books. It would seem that something of this sort ought to be in the regular course for metallurgical engineers.—H. W. G.

Onward March of Magnesium

THOSE in touch with developments in the metal and alloy industries have realized that there has been rapid progress in the manufacture and use of magnesium and its alloys. Concrete evidence of some of this progress is at hand from statistics published by U. S. Bureau of Mines. According to these data, the production in 1934 of "new-magnesium ingot and stick," sold or used, was 4,249,838 lb. as compared with 1,434,893 lb. in 1933, with 791,699 lb. in 1932, and with only 500,000 to 600,000 lb. each year, 1931 and 1930.

This is an impressive showing. The production last year represents an increase of 196 per cent over that of 1933. It is many times that of the three preceding years.

Of interest in this development is the fact that the output of magnesium alloy ingot expanded in 1934 more than 43 per cent over 1933 while the production of castings increased as much as 71 per cent last year over the year previous. Of interest also is the trend in structural shapes—in 1934 the output at 94,935 lb. was over 100 per cent larger than it was in 1933.

Doubtless many are familiar with the large trucks which transport from maker to distributor as many as three or four automobiles—a really spectacular sight. These developments are due largely to the advent of large sheets and structural sections of magnesium alloys. Weight reductions of approximately 25 per cent are claimed possible as compared with trucks built of other light alloys and of approximately 75 per cent as compared with the old orthodox wood and steel construction. For example one type of truck, or "Dow-metal trailer," capable of carrying four passenger automobiles, weighs about 5,700 pounds and contains 2,000 pounds of Dow-metal which is 35 per cent of the total weight. In other styles, Dow-metal constitutes 30 to 40 per cent of the gross weight.

In not only the metallurgy but also in the heat treatment of magnesium and its alloys have rapid advances been made. In progress it parallels to some extent the early history of aluminum. The greater cost—30 cents per lb. for ingot magnesium in 1934—is naturally a handicap to its greater use. The entire development is a result of metallurgical research.—E. F. C.

Foundry Production of Nickel Silver—II

By T. E. KIHLGREN

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IN the June issue of METALS & ALLOYS, *the author discussed the foundry procedure which has been found to produce good castings. In this, the concluding portion of the article, Mr. Kihlgren deals with laboratory and experimental foundry tests and their practical application.*

Part II.—Laboratory and Experimental Foundry Tests

WE have described, in some detail and in logical sequence, the foundry procedure which has been found to give good castings; it may now be of interest to discuss the results of laboratory and experimental foundry tests and their practical application to the development of a suitable founding technique. With the innumerable factors to be considered it will be necessary to confine ourselves to those which appear most important.

Soap Dish Cast in 20 Per Cent Nickel Silver, Federal Specification Alloy. (Courtesy of Charles Parker Co.)

Combination Drinking Glass and Tooth Brush Holder Cast in 20 Per Cent Nickel Silver. (Courtesy of Charles Parker Co.)

"Deoxidation" Studies: (Federal Specification Alloy)

This phase of the production of Nickel Silver castings is very important; and a quite complete study of it has been made, using a variety of deoxidants.

At the outset it should be emphasized that a number of factors are involved in the producing of castings in commercial shapes which do not enter into the production of well designed and easily fed tensile bar castings, and the use of the tensile test for following effects of variations in foundry technique is consequently subject to decided limitations. These factors involve the presence of gases evolved from the core, stresses set up in the castings by contraction about the core, turbulence and reuniting of metal streams, nonuniformity of section of the castings, and other complications.

Thus, while a deoxidation procedure which gives good castings in commercial shapes will also give sound tensile bars, although not necessarily bars of the highest strength, the converse frequently is not true. Therefore, the use of a test casting which in some measure involves the factors entering into the production of commercial castings is more apt to develop information directly applicable to foundry practice than is the use of well fed tensile castings. Fig. 7 shows the type of casting used to follow the effect of variations in deoxidation practice.

Hydraulic and Fracture Tests

The melts were all made in unlined clay graphite crucibles using a moderate charcoal cover and were cast into green sand. A pouring temperature of approximately 2400 to 2450 deg. F. was used.

The results of hydraulic tests are summarized below:

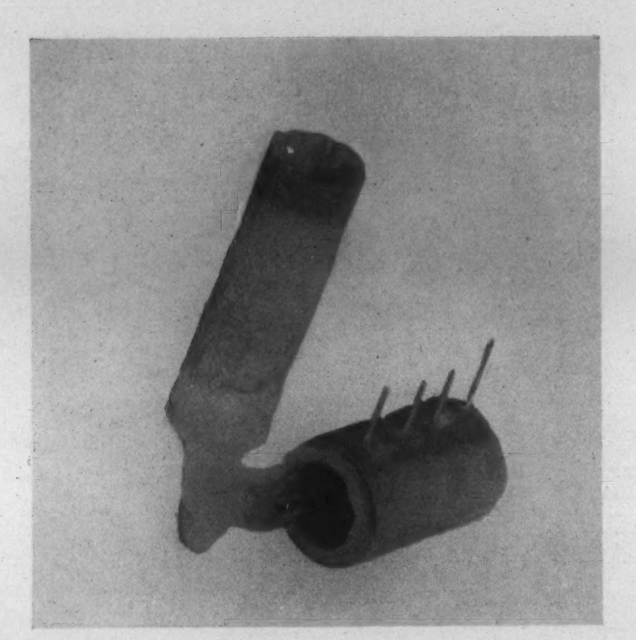


Fig. 7.—An Hydraulic and Fracture Test Casting.

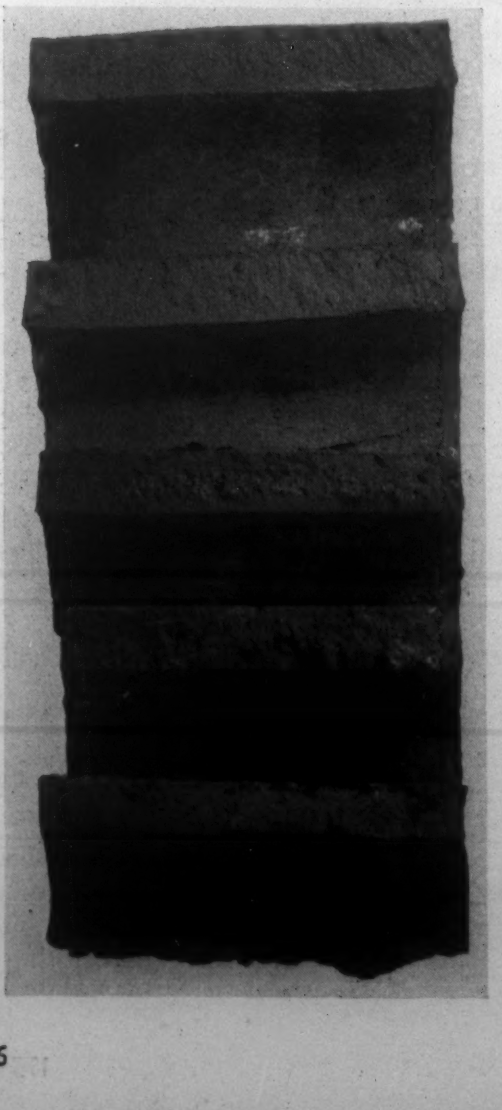
No.	Deoxidizers	Water Pressure 40 *	Pounds per sq. in.*
1	0.10% Silicon	x	x
2	0.30% Silicon	xx	xxx
3	0.05% Lithium	x	x
4	0.05% Boron	x	x
5	0.10% Ti; 25% Mn	x	xx
6	0.25% Manganese	x	xx
7	0.05% Magnesium	OK	OK
8	0.05% Mg + 0.10% Mn........	OK	OK

* OK = Did not leak
x = Sweated
xx = Leaked readily
xxx = Leaked badly.

Pressure tight castings were only obtained in the case of Nos. 7 and 8, treated with 0.05 per cent Mg. and with 0.05 per cent Mg. + 0.10 Mn. The others leaked to varying degrees despite the fact that all of the melts were quiet in the crucible and molds, and the sprues showed good "pipes."

The hydraulic test is subject to decided limitations since leaks will occur only when there is a continuous, though at times tortuous, passage from the inside of the casting to the exterior through which the testing fluid can make its way. Therefore, when used alone the hydraulic method requires a large number of tests to obtain statistical data in order to draw valid conclusions. However, a study of fractures of castings affords a surprisingly sensitive means of studying the soundness and a correlation of the fracture and hydraulic tests permit the drawing of valid conclusions from a relatively small number of tests.

Fig. 8.—Effect of Various Deoxidizers on Fractures of Nickel Silver Bushings.



SHOWING EFFECT OF PROPER DEOXIDATION
With—
0.10% Manganese
and
0.05% Magnesium

SHOWING EFFECT OF PROPER DEOXIDATION
With—
0.10% Manganese
0.05% Magnesium
and
0.02% Phosphorus

SHOWING EFFECT OF ADDITION OF
0.05% Boron

SHOWING EFFECT OF ADDITION OF
0.30% Silicon

SHOWING EFFECT OF EXCESSIVE MANGANESE
0.25% Manganese
0.05% Magnesium

After hydraulic tests had been made, the bushings were therefore fractured longitudinally in four places—along the parting line at and opposite the gate, in the top of the cope, and at the bottom of the drag.

In Fig. 8 the fractures of bushings made with some of the above deoxidizers are shown photographically, and in Fig. 9 they are shown schematically in greater detail.

The undesirability of traces of silicon in bronzes of the red brass type has frequently been referred to by brass foundrymen, its presence being invariably accompanied by an excessive percentage of "leakers." It appears that silicon in amounts as little as 0.10 per cent (added) is also highly objectionable in Nickel Silver containing lead. Fig. 10 shows the peculiar lacy network on the surface of the castings treated with silicon; this is characteristic and is pronounced with the addition of 0.3 per cent silicon and frequently noticeable with 0.10 per cent silicon. The network also appears to be a focal point for hot cracks. Furthermore, fractures obtained on castings treated with silicon are invariably very coarse grained as may be observed from both photographs.

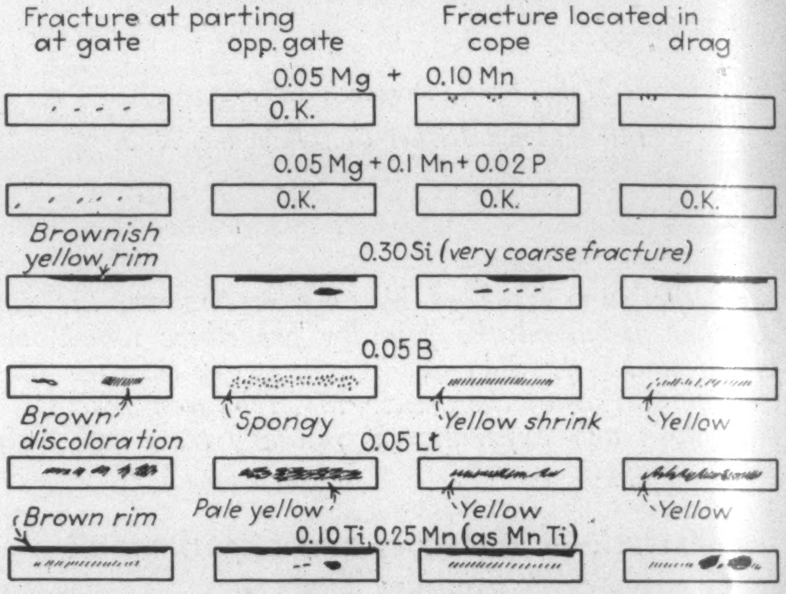


Fig. 9.—Appearance of Fractures of Bushings Treated with Various Deoxidizers.

Melt-down losses of silicon included in the initial charge are of the order of 50 per cent, melting in oil-fired crucible pit furnaces. Inasmuch as a residual content in the castings of 0.05 to 0.07 per cent has been found to be associated with leakers, careful selection of raw materials is very important. In purchasing ingot and Cu-Ni shot therefore the necessity for keeping silicon low, and preferably absent, should be emphasized.

Observation of Figs. 8 and 9 also shows that the addition of such highly reactive elements as boron, lithium and titanium produced poor fractures with spongy and discolored areas despite the fact that the molten metal was quiet in the molds and gave no indication of gas evolution. Considerable slagging of the crucible took place with some of these elements and it was suspected that some silicon was being reduced from the clay-graphite crucible.

The lithium-treated melt was analyzed for silicon, a value of 0.02 per cent being obtained. Comparison with a Mg + Mn-treated melt, which analyzed 0.004 per cent Si, indicates the probability of about five times as much "pick-up" of silicon in the former. Lithium, and other highly reactive elements, added in amounts sufficient to leave merely a trace after combining with the oxygen present might be satisfactory; however, in practice such a balance would be difficult to secure. Further, the charges will generally contain a reasonable percentage of scrap gates and risers and the repeated use of such additions may ultimately cause an accumulation of an undesirable amount of silicon.

Since magnesium plus manganese (Mg + Mn), gave consistently pressure-tight bushings and rather good fractures, a number of tests were made to develop the optimum amounts. The observations on the fractures are graphically summarized in Fig. 11. In this figure the effect of variations in manganese is shown for two magnesium levels, 0.02 per cent and 0.05 per cent respectively. Used alone, 0.05 per cent of magnesium works quite well, but 0.02 per cent is inadequate. The addition of manganese, added a few minutes before the magnesium, is helpful, but as may be observed, an excessive amount is undesirable. The addition of 0.25 per cent manganese is accompanied by tendency for the occurrence of "dirt" or dark inclusions in the fracture a little below the surface; this effect is exaggerated at 0.50 per cent Mn. The further addition of 0.02 per cent phosphorus, shortly before pouring, is effective in clearing the surface of the melt and permitting more efficient skimming. An excess is undesirable since it adversely affects the ductility.

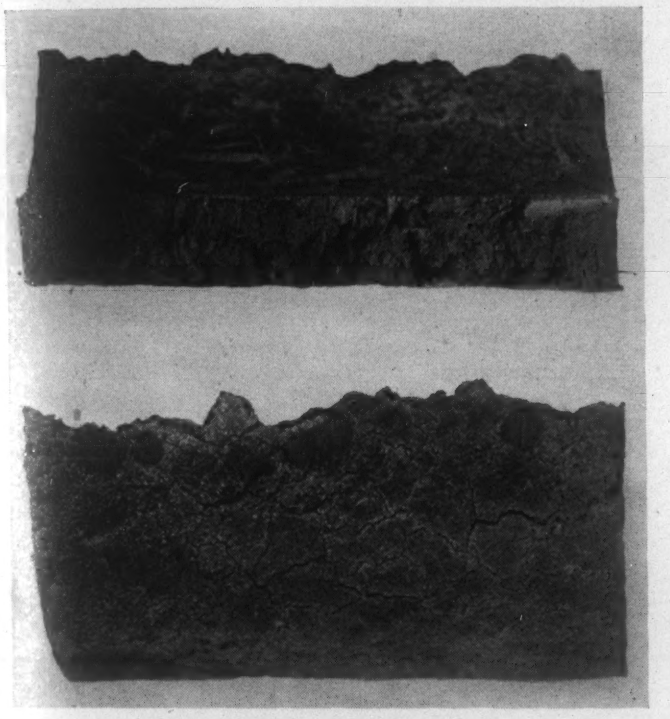


Fig. 10.—Nickel Silver, 20 Per Cent, Federal Specification Alloy, Treated with 0.30 Per Cent Silicon.

Based on our present knowledge, the best deoxidation treatment for the Federal Specification type of alloy involves the use of 0.10 per cent of manganese + 0.05 per cent of magnesium + 0.02 per cent of phosphorus. Details as to proper procedure have been related under "Foundry Procedure for Deoxidation," in Part I. [METALS & ALLOYS, June, 1935.]

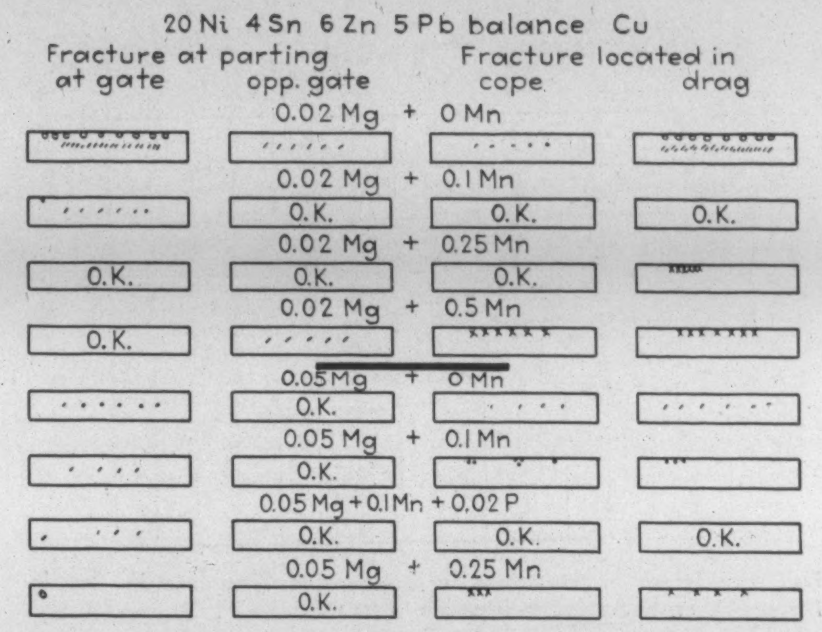


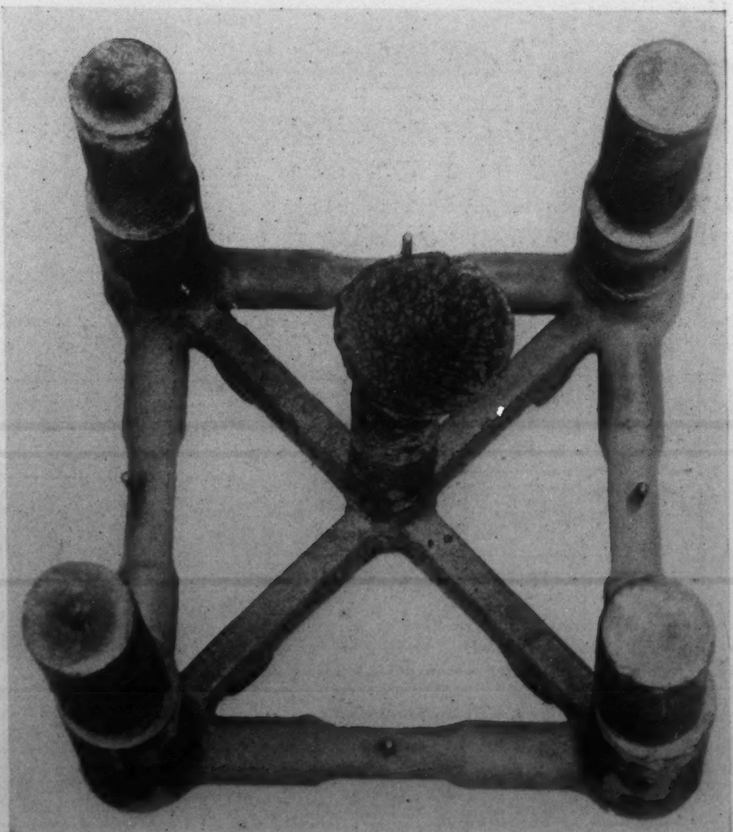
Fig. 11.—Appearance of Fractures of Bushings Treated with Varying Amounts of Manganese and Magnesium.

Effect of Deoxidation Procedure on Tensile Properties

Using the same alloy as in the previous tests, the effect of variations in deoxidation procedure on the tensile properties was ascertained. The type of tensile casting is shown in Fig. 12, and the results of tensile tests are shown in Fig. 13, arranged in order of descending tensile strengths, the deoxidizers used being indicated at the top of the figure. It should be mentioned that it has not been feasible to determine the optimum amounts for each deoxidizer and it is conceivable that some of the additions which seem ineffective or undesirable may be useful in larger or smaller amounts than employed in the tests.

We have previously noted that the melting procedure which gives sound test bars may not necessarily be well adapted to the production of pressure tight castings in commercial shapes. It will be observed that tensile bars made from melts treated with silicon, alone and with other elements, gave excellent strength properties with good ductility (except when used in conjunction with 0.05 per cent boron) and the

Fig. 12.—Casting for Bars for Tensile Tests.



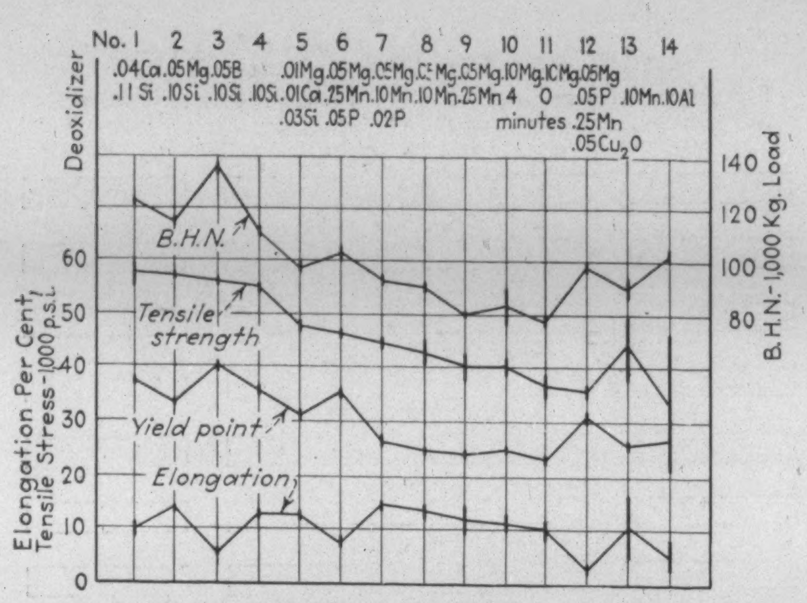


Fig. 13.—Effect of Variations in Deoxidation Procedure in Tensile Properties of Federal Specification Alloy: 20 Ni, 4 Sn, 6 Zn and 5 Per Cent Pb.

fractures were clean and uniform, (though quite coarse grained.) However, as we have already warned, the presence of silicon in castings made from this type of alloy is decidedly inimical to securing of pressure tightness.

An examination of the Brinell hardness curve in some measure explains the higher strength properties of silicon melts. A comparison of the melts treated with silicon and with 0.05 per cent magnesium + 0.10 per cent manganese +0.02 per cent phosphorus shows the former to give castings having a BHN about 20 points higher. Apparently precipitation of an excess constituent, probably a silicide, accounts for the higher hardness of the former. It must be emphasized that silicon should *not* be used as a deoxidizer in *leaded* Nickel Silver castings which must be pressure tight.

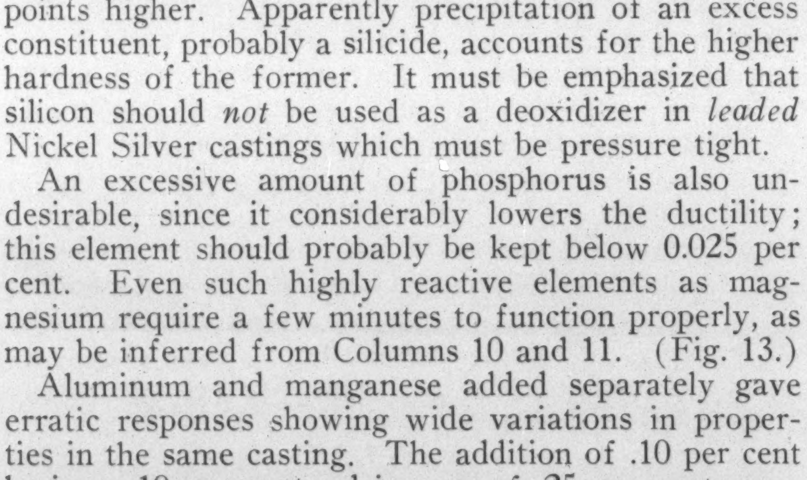
An excessive amount of phosphorus is also undesirable, since it considerably lowers the ductility; this element should probably be kept below 0.025 per cent. Even such highly reactive elements as magnesium require a few minutes to function properly, as may be inferred from Columns 10 and 11. (Fig. 13.)

Aluminum and manganese added separately gave erratic responses showing wide variations in properties in the same casting. The addition of .10 per cent barium, .10 per cent calcium or of .25 per cent manganese + .05 per cent phosphorus was found ineffective.

Temperature Control

Frequently, defective Nickel Silver castings are due to improper pouring temperatures and generally the tendency, as we have mentioned, is to pour Nickel Silver too cold. For the "Federal Specification" type of alloy a temperature of 2400 to 2450 deg. F. is suitable for moderate sized castings; the pouring range is from about 2500 deg. F. for light castings to possibly 2300 deg. F. for heavy castings of fairly uniform sections. The Nickel Silvers in general should be poured 250 to 450 deg F. above the melting point.

Fig. 14.—Cooling Rate of 150-Lb. Crucible Melt during Pour.



Measurement of Pouring Temperatures

Due to the high temperatures involved, accurate control of temperature is not easily secured. We have found the use of a chromel-alumel (14 gage) bare wire immersion couple, of the extensible type, in conjunction with a portable potentiometer, to work fairly well provided certain precautions are observed. The observed temperature, based on the ordinary millivolt temperature calibration supplied by the manufacturers of the wire, represents the temperature of the surface of the melt. Comparisons made over a range of several hundred degrees, between the temperatures in the center of the melt (measured with a sheathed platinum-rhodium platinum thermocouple) and that observed with the bare couple indicated that the latter was about 75 deg. below the former. Therefore, to correct this differential, about 75 deg. F. should be added to the observed reading. (In passing, it may be noted that some bare immersion couples commercially available appear to embody a correction of about this amount.)

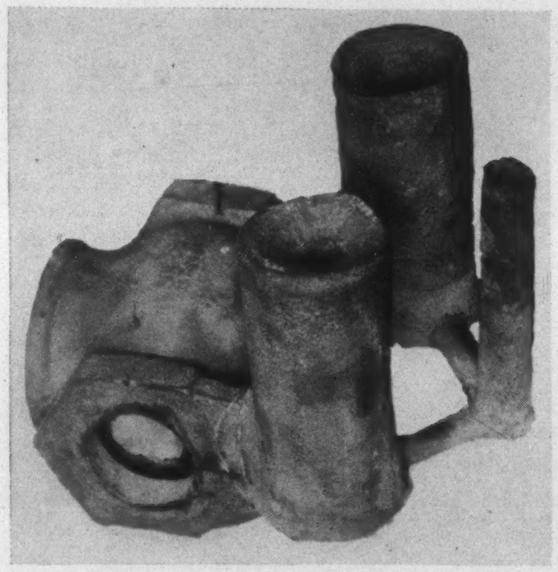


Fig. 15.—Nickel Silver, 20 Per Cent, Valve Body Showing Method of Gating. (Pouring Temperature, 2450 deg. F.)

Another precaution to be observed is that of using a fresh junction for each measurement. Where glass slags are used, this type of couple is not very satisfactory, erratic readings being obtained; under these conditions some sort of protected couple may be more suitable. Using a charcoal cover, or no cover, however, we have found the bare couple adequate for temperatures ranging up to 2500 deg. F. About 7 or 8 secs. are required to obtain a temperature reading. In pouring experimental castings over a range of temperatures, a record of the elapsed time between readings has been found very useful and permits the obtaining of a cooling curve of the melt, which very effectively brings out any chance errors in readings.

Fig. 14 shows a typical cooling curve obtained on a 150-lb. crucible melt with the chromel-alumel couple described above, in which the measured temperatures are plotted against the elapsed time during pouring. In this case the first reading was apparently low, while the remainder of the measurements appear entirely consistent.

While it may not be feasible to keep a time record of pouring in commercial production, nevertheless more than one reading should be made, and a reading at the end of the "pour" will be found useful as a check to determine whether all the castings have been poured hot enough.

It may be noted that the rate of cooling of the melt during the pouring cycle is quite uniform. Generally speaking, a cooling rate of about 40 deg. F. per min. may be assumed in pouring a 150-lb. melt of Nickel Silver.

Measurement of Pit Temperatures

It is of course inevitable that some drop in temperature will occur between the time the pot is pulled and pouring is started. It is therefore important that the crucible is drawn hot enough so that the melt temperature will not drop below the initial casting temperature desired. While some approximation of the "pit temperature" can be made by an experienced eye, a more reliable estimate may be obtained by use of a "pit thermocouple." We have used a chromel-nickel bare wire (14 gage) immersion couple of the extensible type, adapted for use in the pit, with fair success. The barrel of the instrument is long enough so that the thermocouple may be lowered into the crucible in the pit without undue discomfort to the operator. The leads of the couple are connected to the portable type millivolt-potentiometer. While the "pit measurements" are of course not accurate at the very high temperatures involved (2700 deg. F.), the instrument does indicate satisfactorily whether the melt temperature is sufficiently high to insure a suitably high initial pouring temperature.

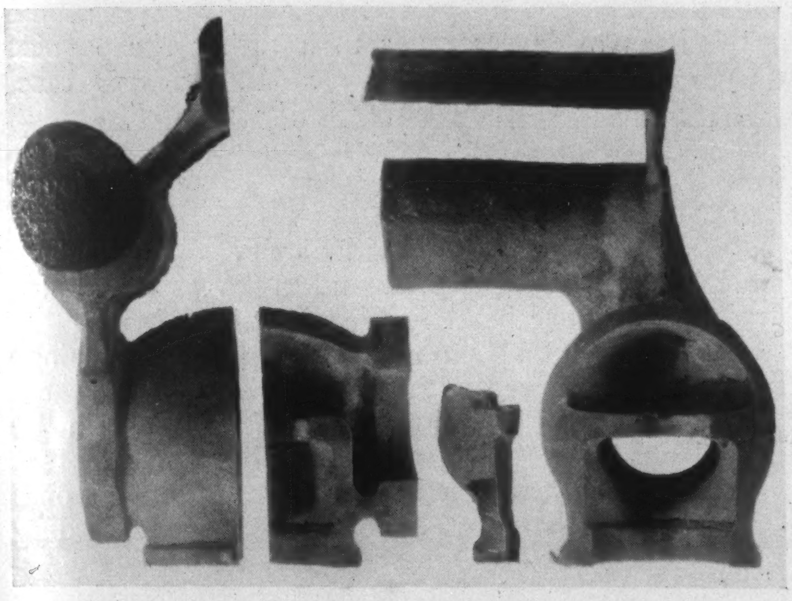


Fig. 16.—Nickel Silver, 20 Per Cent, Valve Body, Showing Cross Section and Fracture through Heaviest Section.

Experiments On Molding Procedure

In many instances, defective castings may be attributed solely to poor molding technique. Frequently it has been found that brass foundries attempt to use the same gating as for red brass with disastrous results. In general, gates and risers, two to three times the weight of those used for red brass, should be provided for Nickel Silver. This is particularly important in the case of castings, which must be hydraulically, or gas, tight.

It is essential that the risers be properly located on the pattern and it is in this respect that errors are most frequently made. Too often, risers are placed in such a way that they receive metal which has run through the mold and become cold before entering the riser and are therefore unable to supply hot metal to the casting; under such conditions they are more apt to be harmful than beneficial. Risers should be located so that they receive the hottest metal and are thus able to perform their intended function of feeding the casting. Fig. 12 shows a method of gating which has been found to work very well for the "Federal Specification" alloy.

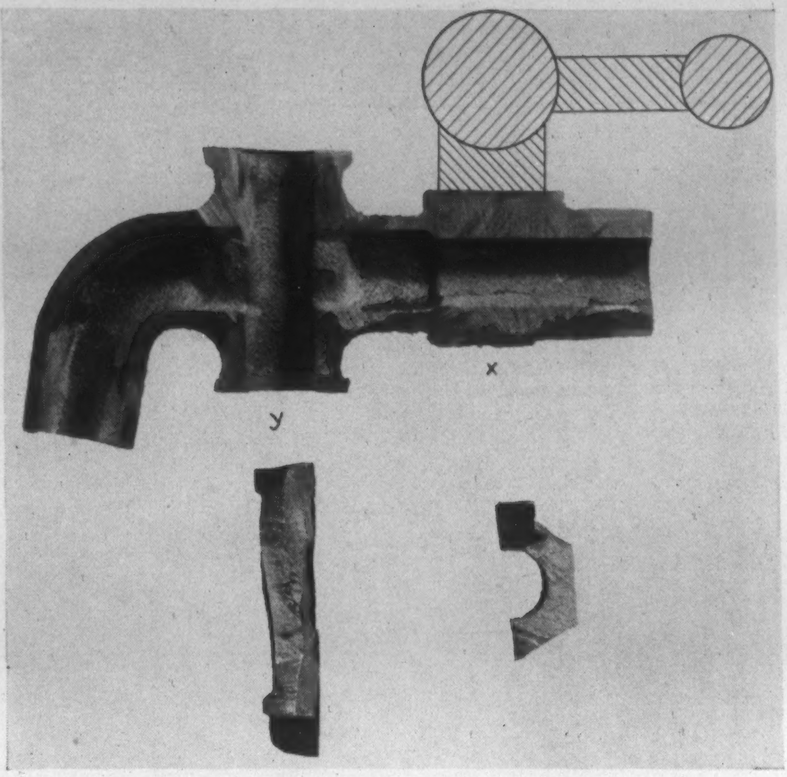
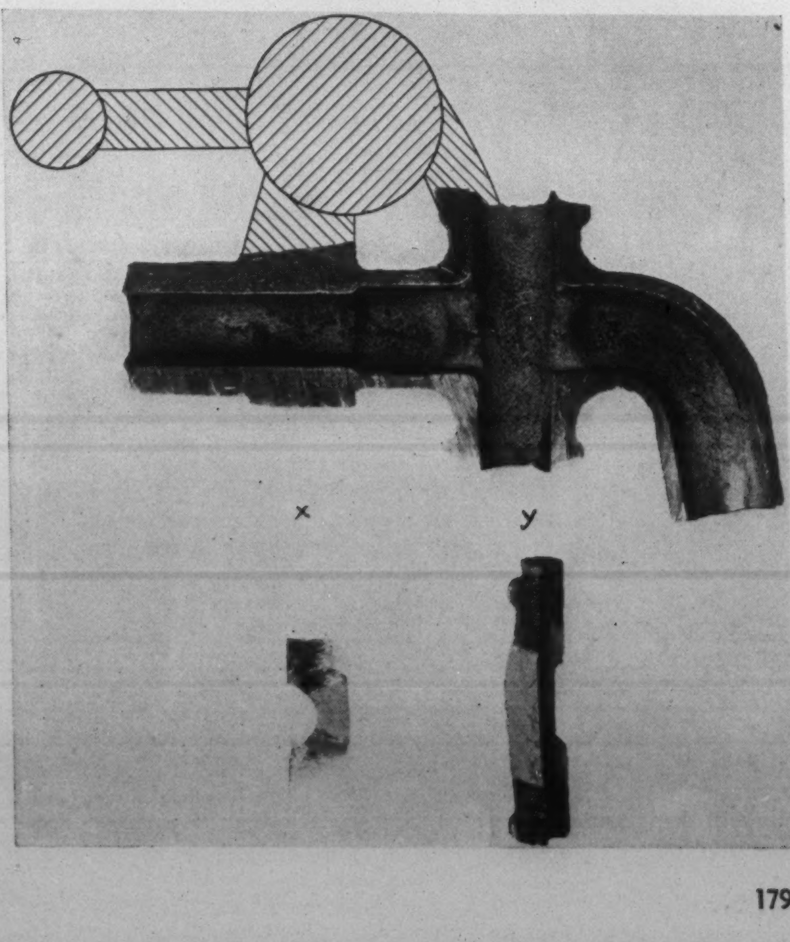


Fig. 17.—Nickel Silver, 20 Per Cent, Spigot, Fractured to Show Effect of Improper Gating.

The metal enters the risers through a choke gate and runs from the risers into the casting through generous gates; the risers thus receive hot metal at the end of the pour and can, in turn, feed the casting. The choke gate makes it possible to keep the sprue full and float any dirt and dross on the surface, and also eliminate turbulence and agitation of the stream of metal. Fig. 16 shows the gating in more detail and also the cross section, and a fracture through the heaviest section; the latter appeared uniform in color and quite free of interdendritic shrinkage. This casting was poured from a 150-lb. melt (oil-fired pit furnace) and was molded in a synthetic green sand of 60-80 perme-

Fig. 18.—Nickel Silver, 20 Per Cent, Fractured to Show Freedom from Shrinkage When Properly Gated.



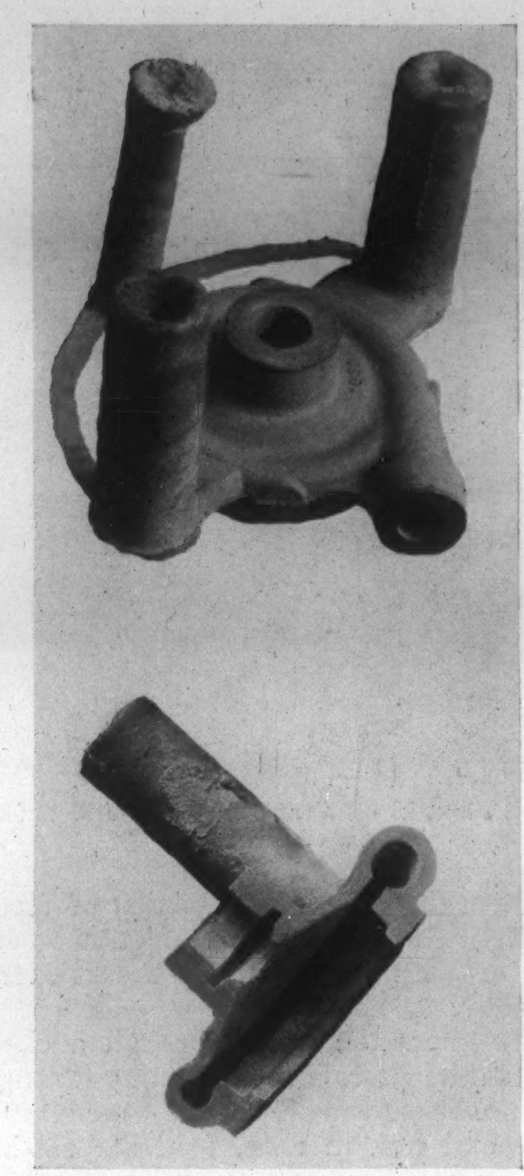


Fig. 19.—Nickel Silver, 20 Per Cent, Centrifugal Pump Casting. (Pouring Temperature, 2425 deg. F.)

ability (14% clay, balance silica), and faced with graphite (dusted on, dry). It successfully resisted 1000 lb. per sq. in. hydraulic pressure under test. The surface was quite satisfactory and no difficulty was encountered in applying a good buff without any preparation of the surface other than the normal cycle of polishing operations.

Figs. 17 and 18 show the effect of changes in gating on the soundness of the casting. When gated as shown in Fig. 17, the spigot was entirely sound near the gate at x but showed a large shrink at the point y. When the casting was gated at both x and y and fed from a larger feeding riser as shown in Fig. 18, the fractures became quite satisfactory. Merely increasing the diameter of the riser from 1½ to 2 in. (and gating only at x) almost eliminates the shrink. The gating method shown in Fig. 18 is preferable since it permits feeding both of the relatively heavy sections with hot metal from the riser and will probably permit somewhat greater latitude in pouring temperature.

Fig. 19 shows a pump casing, also cast from a 150-lb melt. It was fractured in several places both near the gate and at various distances from it; all the fractures were found to be excellent. Prior to sectioning it was hydraulically tested at 1000 lb. per sq. in. pressure without any leakage.

In all of the castings the deoxidation procedure indicated in the section on "deoxidation" was employed and the "Federal Specification" composition was used.

Fig. 3 [in Part I] shows a casting in which all the metal parts for a clarinet are included on one pattern. It is included because it is a unique illustration of casting of a large number of very small castings; some of the keys or levers taper to a rather sharp point and these were faithfully executed. In this case, a Nickel Silver without tin or lead was used.

In the casting several pieces of moderate size (elbows, lock nuts, etc.) on one board, it has been found helpful to put blind risers on the runner at the points where the gates for the individual pieces are attached. These "buttons" supply hot metal to the gates and also furnish a pressure head for feeding the casting.

Fig. 4 [in Part I] shows a refrigerator door hinge cast in Nickel Silver with gates and risers attached. Fig. 5 [in Part I] is a photograph of the hinge in the finished condition (weight about 15 lb.).

Each type of casting will of course present its own problem as to the most effective method of feeding and will requisite experimentation on the part of the individual foundryman. It is preferable to err in the direction of over-generous feeding of the casting at first, and then cut down gradually to a point where a safe margin exists.

British Nitriding Steel Contains Nickel

A NITRIDING steel containing nickel has been developed by British metallurgists according to *Nickel Steel Topics*. The English Steel Corp., Sheffield, by adding nickel to nitriding steels, claims that greater toughness and shock resistance are imparted to the core, and that, while it tends to slightly lower the case hardness, it renders the case tougher and less likely to crack or spall off under pressure.

The composition of the nickel nitriding steel, to which has been given the trade name "VCM," is as follows: C 0.25 to 0.35, Si 0.30 max., Mn 0.50 to 0.60, Ni 0.50 to 0.70, Cr 0.70 to 1.00 and Mo 1.00 to 1.25 per cent. The recommended heat treatment is: Quench in oil from 1600 deg. F. and temper at 1175 to 1275 deg. F. The physical properties are described as: Yield point, 112,000 lb. per sq. in.; minimum stress, 135,000 to 155,000 lb. per sq. in.; elongation, 18 per cent min.; reduction of area, 50 per cent, min.; Izod impact, 40 ft. lb. min. and Brinell hardness, 277 to 321.

Nitriding steels have been discussed quite fully by authorities in this country in recent years. French and Homerberg presented a paper before the American Society for Steel Treating in 1932 on nickel in nitriding steels, which was published in the *Transactions* of the society, for that year, page 481. Of kindred interest was an article, published in METALS & ALLOYS, March, 1935, page 59, by Strauss and Mahin, on aluminum-free nitriding steels, in which Cr-Mo-V steels were discussed.

Last Year a Record in Molybdenum Output

DESPITE the severe depression in the steel industry, the production of molybdenum in the United States in 1934 was by far the greatest for any one year on record. The increase over 1933 was about 65 per cent, according to the U. S. Bureau of Mines. Last year the mine output of molybdenum ore was 1,339,000 net tons which yielded 9,119 tons of concentrates which contained 9,362,000 lb. of metallic molybdenum. By contrast, in 1933 the mine production of ore was 705,000 tons, yielding 5,348 tons of concentrates of which 5,682,000 lb. was metallic molybdenum.

The increase in 1934 is not entirely accounted for by larger consumption in this country. Demand from foreign countries last year for concentrates, in particular, and for ferromolybdenum and calcium molybdate was unusually heavy. Reliable information is to the effect that this foreign demand this year is fully equal to that of 1934 and is, if anything, somewhat better.

Recent Progress in Steel Making Reported from Germany—III

A Correlated Abstract

BY S. EPSTEIN

Metallurgist, Battelle Memorial Institute, Columbia, Ohio.

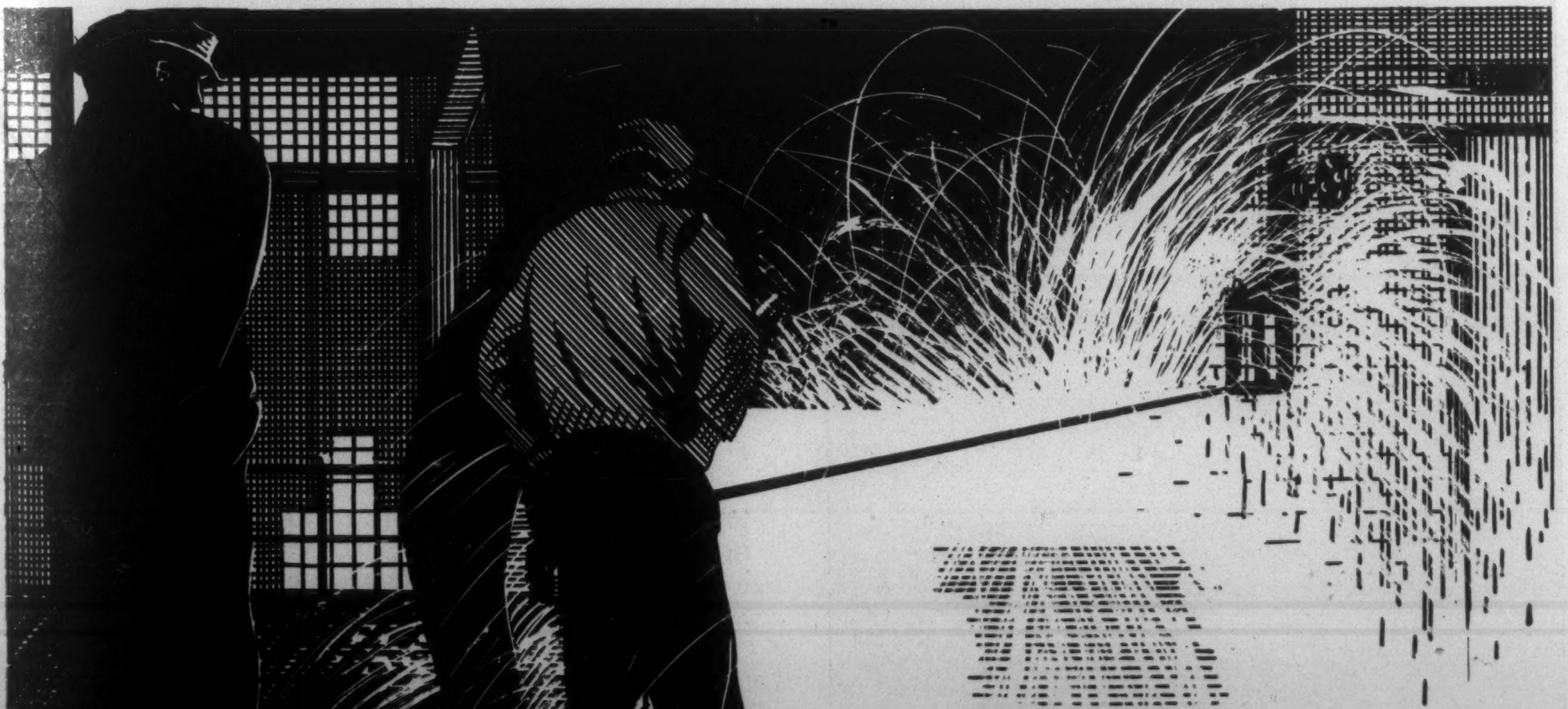
THE FIRST AND SECOND installments of this interesting and valuable series by Mr. Epstein, which appeared in the May and June issues respectively, discussed "Equilibria between Slag and Bath" and "Gases in Steel." The series is continued in this, the third section, which deals with "Desulphurization in Basic Open-Hearth Steel." Succeeding subjects to be included are defects in steel and some recent practical developments.

Desulphurization in Basic Open-Hearth Steel

SINCE highly basic and reducing conditions are most favorable for desulphurization, this is most cheaply performed in the blast furnace where the S in the pig iron can be brought down to about 0.025 per cent. However, an appreciable reduction in S can also be accomplished in the basic open-hearth. The S entering the open-hearth through the pig iron, scrap, dolomite, limestone, fluorspar, coal, etc. may amount to 0.05 per cent of the charge and over; in addition some S may be absorbed from the furnace gases, particularly during the meltdown. It is desirable to reduce this content of S, and under good commercial operating conditions a reduction of as much as 40 per cent, from about 0.05 per cent maximum S content of the bath to about 0.03 per cent S in the finished steel, may be effected.[21, 22, 23]

The importance of this possible S reduction in terms of steel cleanliness is sometimes not fully appreciated, the tendency being to emphasize O as a source of inclusions and to overlook S. Yet S forms inclusions just as does O. The volume of sulphide inclusions formed by a certain amount of S is about equal to the volume of oxides formed by an equal amount of O. Since the O content in steel is usually considerably below the S content, the sulphides in steel are generally more numerous and larger than the oxides. Of course, for many grades of steel, a S content of somewhat above 0.05 per cent would do no particular harm (unless undue segregation occurred); still it is good practice to keep the S down. In some grades of steel it is essential to lower the S as much as practicable; for example, Nead and Washburn[20] state that for the best deep-drawing properties the S content of deep-drawing sheet should preferably be under 0.03 per cent.

From a Drawing by Charles Perry Weimer



Basic reducing conditions being favorable for the elimination of S by means of the slag, there is naturally a relationship between desulphurization and deoxidation. Recent trends in slag control have been toward lower CaO/SiO_2 ratios and consequent lower FeO contents in the slag. Lower FeO in the slag tends to favor S elimination, but a lower CaO/SiO_2 ratio tends to hinder it.

In the basic open-hearth process, S elimination may take place by means of the furnace gases and through the slag. Most of the MnS present in the steel bath is probably in solution,[25] so that little S elimination would take place by physical levitation of MnS particles. Desulphurization proceeds mainly by chemical reactions between the furnace gases, slag, and bath.

Furnace Gases

The principal gaseous fuels used in open-hearth practice are natural gas, coke-oven gas, and producer gas. Natural gas is S free, but coke-oven gas and producer gas contain S. Diehl[23] has strikingly pointed out, as shown in Table II, that if only a small proportion of the S in these fuels were absorbed by the bath, the melt would be ruined.

able II.—Quantity of Sulphur Present in the Fuel For An Open-Hearth Heat. Diehl[23]

	Natural Gas	By-Product Gas	Producer Gas
Cu. ft. per ton steel	5,000	10,000	35,000
Grains of S per cu. ft.	0	4	0.75
Tons of steel per heat	60	60	60
Lb. S per heat	0	343	225
Original content of S in bath, per cent	0.030	0.030	0.030
Final S content of bath if all S were absorbed	0.030	0.285	0.197

Fortunately, the proportion of S that may be picked up by the open-hearth bath from the S present in the fuel gases is very small. As was pointed out by Herty,[24] an equilibrium is established under operating conditions. If, for any bath and slag composition, the S in the fuel gas or in the waste gas after combustion has taken place is over a certain equilibrium value, there will be a S pickup; if the S is under this value, S elimination from the bath to the waste gases will result.

From a Drawing by Charles Perry Weimer

The S is originally present in the fuel gases as H_2S, and it was formerly surmised that absorption of S took place according to the reaction $Fe + H_2S = FeS + H_2$. However, as Herty[24] pointed out, under open-hearth operating conditions the H_2S in the fuel gases is at once oxidized to SO_2, so that the absorption of S takes place by the reaction $Fe + SO_2 = FeS + O_2$. Recently, Maurer and Bischoff[26] studied the equilibria of both the reactions $Fe + H_2S = FeS + H_2$ and $Fe + SO_2 = FeS + O_2$. Although they found that Fe can pick up S from H_2S, the latter gas can only exist under strongly reducing conditions, which would not support combustion, so that in the burning gases over an open-hearth bath little H_2S is present; they concluded from actual open-hearth operating data that the distribution of S between the fuel gases and the bath is governed solely by the reaction $Fe + SO_2 = FeS + O_2$, in agreement with Herty's earlier work.

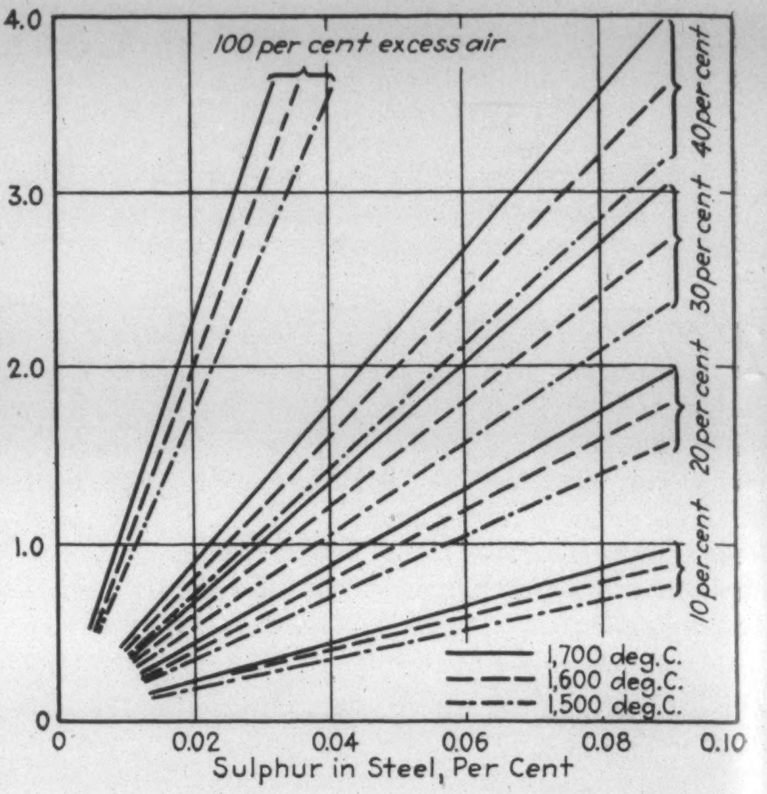


Fig. 14. Effect of Using Excess Air in Burning the Fuel Gas on the Sulphur Content of the Steel. Maurer and Bischof.[27]

As the reaction $Fe + SO_2 = Fe + O_2$ indicates the more O_2 there is present, the less is the tendency for FeS to form; i. e., the more oxidizing the furnace gases, the less likelihood there is of a S pickup. This may at first sight seem to gainsay the dictum that reducing conditions favor desulphurization. The latter refers only to the action of the slag, however, and not to the action of the furnace gases which, as stated, increase in desulphurizing power the more oxidizing they are, as shown in Fig. 14.

Fig. 14 indicates that a decided increase in desulphurization may be obtained by raising the content of excess air. However, there is a practical limit to this recourse, since increasing the excess air lowers the thermal efficiency sharply. Maurer and Bischoff calculated that an increase in the excess air of 10 per cent lowers the temperature of combustion more than 50 deg. C. It should be noted in Fig. 14 that increasing temperature tends to increase the desulphurizing effect of the furnace gases.

The equilibria between the SO_2/O_2 ratio in the waste gases and the S content of the bath, obtained by Maurer and Bischoff in actual open-hearth operations, are shown in Fig. 15. Natural gas is indicated to have a desulphurizing effect. From the curves shown it appears that a value for the ratio SO_2/O_2 in the waste gas of under 0.01, such as may be obtained with producer gas, should tend to keep the S in the bath below 0.04 per cent. The data of Fig. 15 show large scatter, but still the curves should be of some aid to the open-hearth operator in judging whether his furnace gases tend to be sulphurizing or desulphurizing.

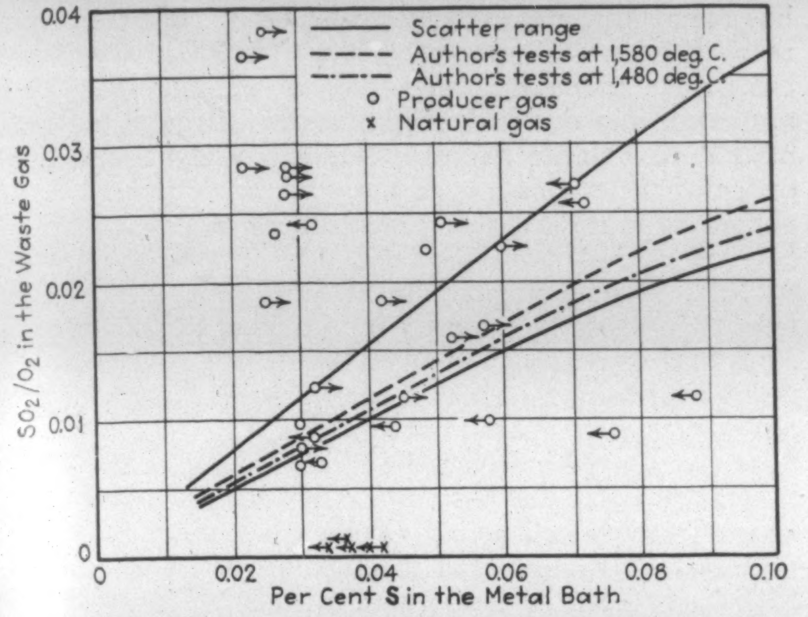


Fig. 15. Relation between Ratio of SO_2/O_2 in the Waste Gas and the S Content of the Steel Bath. Maurer and Bischof.[27]

Since desulphurization by means of the furnace gases is an important means of S elimination, the question of cleaning the gases to remove S comes up. Herty[24] long ago stated that cleaning coke-oven gas for this purpose should prove profitable. Screening of the coal used to make producer gas, so as to eliminate the high S fines, has long been practiced.[23] In the discussion of Maurer and Bischoff's paper,[27] the Thylox process for cleaning coke-oven gas was referred to. In this process[28] the S is removed from the gas as arsenic sulphide, the latter being regenerated by oxidation and the S recovered as pure S. Maurer and Bischoff stated, however, that as far as they were aware no steel plant in Germany has desulphurized its fuel gas.

Slag

With a basic slag over the metal bath, the partition of the total S between the slag and metal tends to such an equilibrium that S is removed from the bath by the slag. The S is held in the slag principally as two sulphides, CaS and MnS. That the former plays far the more important role is indicated by the fact that desulphurization can only be effected by basic slags; there is virtually no desulphurization with acid slags where MnS may form but not CaS. One reason why CaS is a better desulphurizer than MnS is that though both are soluble in the slag, CaS is virtually insoluble in the bath, whereas MnS has an appreciable solubility in the bath.

The reactions for the formation of CaS and MnS may be written as follows:

$$CaO + FeS = CaS + FeO \quad (1)$$
$$Mn + FeS = MnS + Fe \quad (2)$$

According to equation No. 1, the more free lime there is in the slag, the greater is the tendency to form CaS. This is the main reason why a low FeO content of the slag favors desulphurization, since FeO combines with CaO and thus reduces the amount of free CaO. Most probably the increase in desulphurization which accompanies a higher Mn content in the bath is due more to the resulting reduction in the FeO in the slag than to the formation of MnS. Similarly, the presence of SiO_2 in the slag also reduces its desulphurizing power, since this combines with CaO and hence reduces the amount of free CaO.

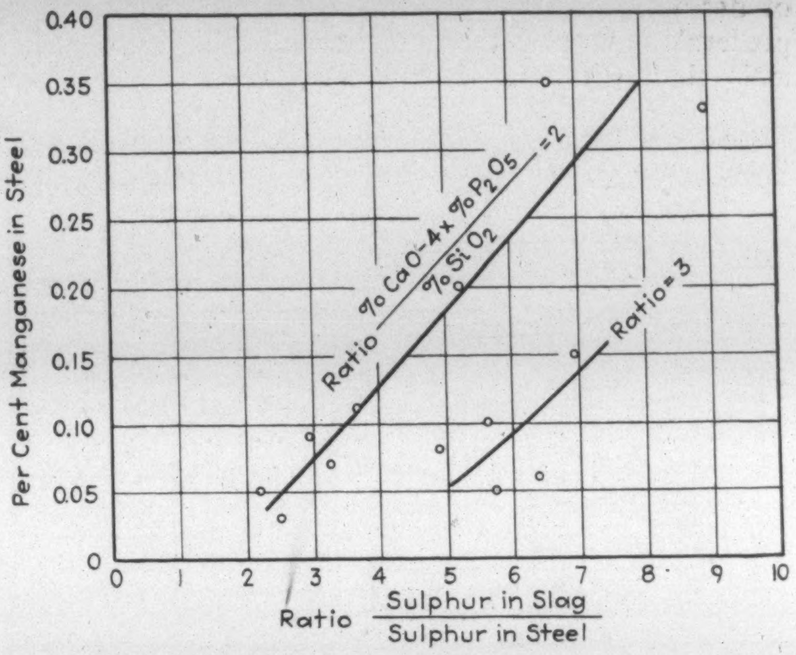


Fig. 16. Effect of CaO/Sio_2 Ratio and of Residual Manganese Content on the Ratio of $\frac{\text{Sulphur in Slag}}{\text{Sulphur in Bath}}$. Diehl[23]

The effect of residual Mn in the bath and of the CaO/SiO_2 ratio on the partition of S between slag and bath is shown in Fig. 16. With increasing residual Mn the ratio $\frac{\text{S in slag}}{\text{S in bath}}$ goes up. However, it will be noted that the CaO/SiO_2 ratio has an even greater

From a Drawing by Charles Perry Weimer

effect. Thus, with a CaO/SiO_2 ratio of 3, a $\frac{(S)}{[S]}$ ratio of 7 is obtained at a residual Mn content of about 0.15 per cent, whereas with a CaO/SiO_2 ratio of 2, a $\frac{(S)}{[S]}$ ratio of 7 is only obtained with a residual Mn content of about 0.30 per cent. From the standpoint of desulphurization alone, therefore, it would be more preferable and cheaper to work with a high CaO/SiO_2 ratio than with a high Mn content.

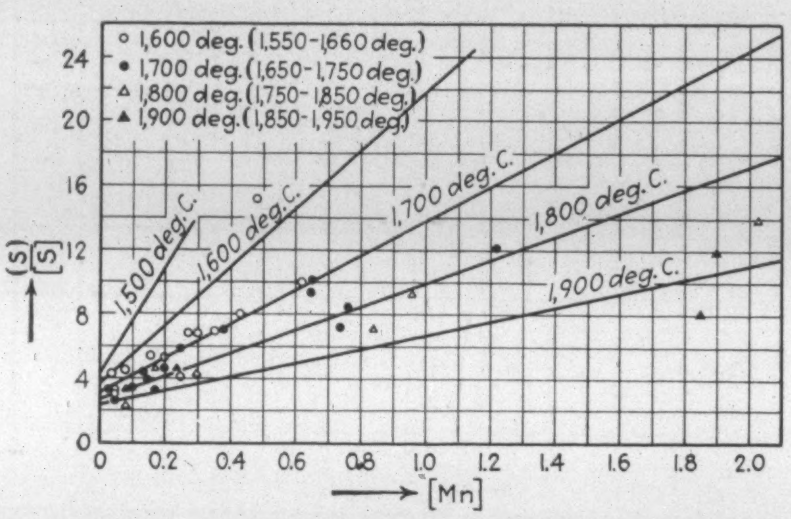


Fig. 17. Partition of S between Molten Fe and Pure FeO-MnO Slags in Relation to the Mn Content of the Bath and the Temperature. Bardenheuer and Geller[29]

It is generally observed that a rise in temperature favors desulphurization. This is not primarily because the separate reactions (1) and (2) are favored by higher temperatures thermochemically as for example, the reaction $SiO_2 + 2\ Fe = Si + 2\ FeO$ is favored by higher temperatures. In fact, exactly the opposite is true. That reaction (2) is not favored by higher temperatures is indicated by Fig. 17, which shows for FeO-MnO slags that with a certain [Mn] the ratio $\frac{(S)}{[S]}$ is greater at lower than at higher temperatures. Likewise, Schenck[4] indicates that temperature has a small effect on reaction (2) as it takes place with basic open-hearth slags.

Higher temperatures are considered to favor desulphurization, not thermochemically but mainly by increasing the fluidity of the slag, thus allowing the reactions between slag and bath to come to equilibrium more readily. Sisco[30] has also suggested that higher temperatures increase the solubility of CaS in the slag; at higher temperatures desulphurization by the furnace gases should be more effective, as indicated in Fig. 14.

Maximum desulphurization should be obtained, therefore, through a highly basic slag made more fluid by a high temperature. A very fluid slag, even though highly basic, would not tend to build up the high FeO content usually found in highly basic slags. However, since the extent to which the temperature can be raised in steel melting is distinctly limited by the furnace refractories, increased fluidity is ordinarily obtained by adding fluorspar.

The effect of fluorspar in favoring desulphurization has received a great deal of discussion,[31] but the exact mechanism is still obscure. Meyer and Görissen[32] recently concluded that the addition of fluorspar does not result in a direct desulphurization through the formation of volatile SF compounds. They found evidence of the formation of the volatile compound SiF_4 according to the following reaction $2\ CaF_2 + 2\ FeS + Si = 2\ CaS + SiF_4 + 2\ Fe$. Although the amount of SiF_4 formed appears to be negligible, this would tend to increase the basicity by reducing the amount of SiO_2 and increasing the amount of CaO, and thus aid desulphurization. At the same time, however, the fluidity is not decreased but apparently increased. Why fluorspar should increase the fluidity while at the same time increasing the basicity is still an open question. Geiger[33] suggested as an explanation some time ago that the SiO_2 eliminated through the volatilization of SiF_4 is replaced by FeO; why this should increase the fluidity is not clear, since highly basic slags high in FeO are ordinarily viscous.

(To be continued)

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Electric Steel in 1934

PRODUCTION of electric steel ingots in 1934 made a splendid recovery with the total of 349,095 gross tons, the largest since the record tonnage of 532,392 tons in 1929. The output last year was 16.4 per cent in excess of the 299,808 tons made in 1933 and compares with 141,328 tons in 1932 which was the lowest since 1921 when only 84,721 tons was reported. This increase last year of 16.4 per cent in electric steel ingots compares with an increase in total ingot production over 1933 of 13.34 per cent.

The relatively large expansion in electric steel ingot production last year is probably explained largely by the increased demand for the rust and heat-resisting chromium and chrome-nickel steels which are produced only in electric furnaces.

If the statistics for the combined production of ingots and castings are studied, an entirely different picture is presented. Total production in 1934 was 14.26 per cent less than in 1933 and 62.1 per cent less than in 1929. Unfortunately the data are not complete because of a lack of reports from some producers. This is unfortunate. It is hoped these will be supplied because a study of the trends of reliable and complete statistics is profitable.

HEAVY ALLOY IRON CASTINGS

By C. C. MILLER

Chambersburg Engineering Co., Chambersburg, Pa.

Hydraulic Press Cap. Weight is 12,000 lb.

WHAT IS A HEAVY," and what is a "light" casting depends on the sort of thing a foundry is used to making. Our plant deals with castings of such a type that, to us, a section up to 5 in. is "light," while our "heavy" sections are up to 3 ft. in castings weighing 50 tons or more.

Most makers of heavy castings are not especially concerned with the physical properties, for the castings are used chiefly for stability and mass. In our case, we need strength and shock resistance, for the castings are used as frames, anvils and the like in forging hammers and in presses.

Cast iron is a suitable material because of its damping or vibration-absorbing properties, but a type of iron of better strength than ordinary soft iron is required. In fact, we need several grades of iron, since in some of the castings, especially the lighter ones used as cylinder liners and valve chambers, wear resistance is required also.

To meet these requirements a fairly low-carbon, superheated, and alloyed iron is required, and we have found it necessary to resort to something beyond cupola melting and something beyond the ordinary nickel-chromium alloy iron.

In order to allow pouring our large castings from properly superheated metal, we have gone to air furnace melting, using 25-ton acid-lined oil furnaces, top charged through a bung type roof, since we often melt 10-ton pieces of scrap. Our heats run about 7 hrs., with an oil consumption of 60 gal. per ton. This melting time allows proper superheating.

But superheating alone is not sufficient to produce high strength iron in the massive sections we deal with, so we must resort to alloying. The fundamental alloying element used is molybdenum. Mackenzie[1] has shown that in a 10-in.-diameter casting of cupola-melted 3.05 per cent C, 1.22 per cent Si, 0.90 per cent Mo specimens taken from the center and the edge are remarkably alike in strength and hardness, his figures for the center being 38,600 lb. per sq. in., tensile strength, 205 Brinell, and for the edge, 39,000 and 207 respectively. This uniformity of properties is what we desired, though we want a rather better strength, which we obtain by air furnace superheating.

In our "medium" sections, a plain molybdenum iron, of 0.30 to 0.50 per cent molybdenum with carbon from

Steam Hammer Sub-Base of Cecolloy, Weight is 105,000 lb.

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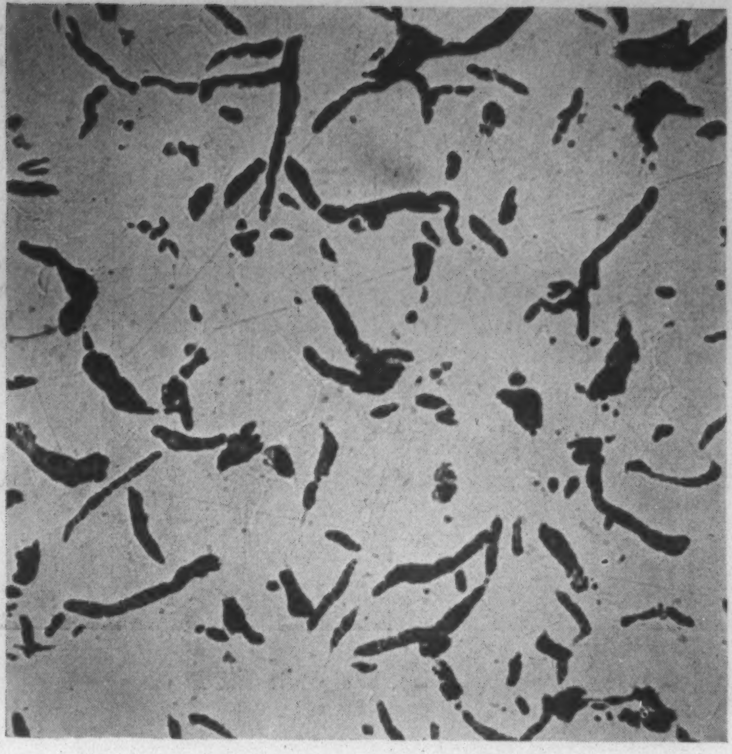
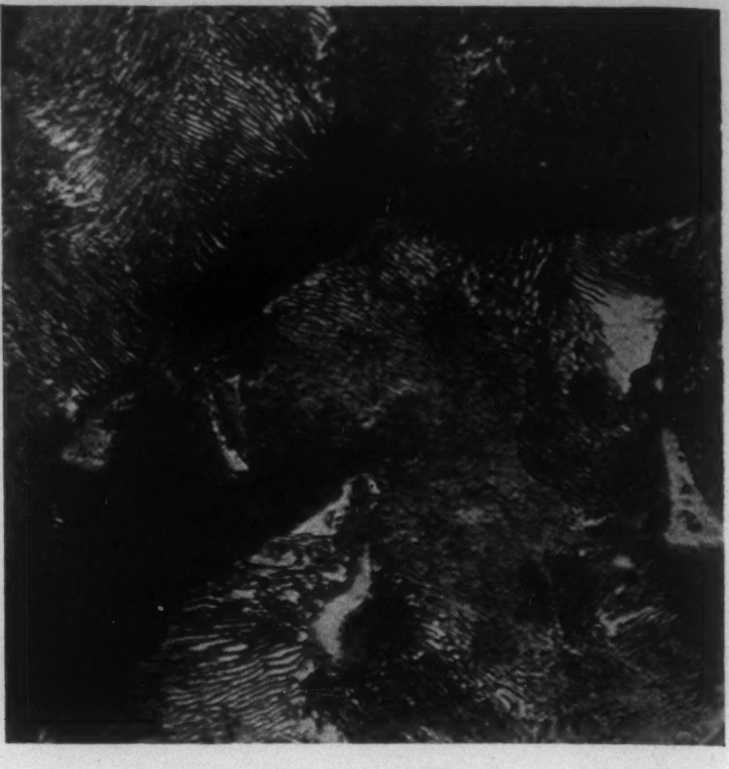
[1] Mackenzie, J. T. Quoted by Gregg, J. L. "The Alloys of Iron and Molybdenum," 1932, page 191.



Photomicrograph of Cecolloy, Unetched. Magnification 100 diameters. The sample is from a 4.5-in. section.



Photomicrograph of the alloy iron at 500 diameters. Same sample as one at 100 magnification.

2.65 to 3.00 per cent and silicon from 0.80 to 1.50 per cent with manganese around 0.80 per cent gives the desired properties. In the heavier sections, with their very slow cooling, it is desirable to have a somewhat less readily graphitized type of carbide, so the molybdenum is augmented by 0.25 to 0.35 per cent chromium.

In the lighter castings, about 0.60 per cent nickel is used with the molybdenum, instead of chromium and in those where wear resistance is an important factor, the nickel is increased to 1.50 per cent.

In melting, the charge is made up of heavy scrap, alloy return scrap, malleable pig, calcium molybdate, petroleum coke, and, when nickel is added, pig nickel. Chromium, when needed, is added as ferrochromium about ½ hr. before tapping. Of course, with the use of back scrap, it is necessary to segregate the heavy and light scrap to prevent interchange of chromium or nickel, and to balance each alloying element to secure the proper composition for the type of castings to be made.

There is, of course, no difficulty, such as is met in the cupola, in holding the carbon low,—in fact the carbon and silicon losses in melting down are rather heavy and petroleum coke is added with the charge. When the charge is melted down analyses for C, Si and Mn are made and corrective additions of ferromanganese, ferrosilicon, and if necessary, of petroleum coke are made.

It is not difficult to hold the sulphur content down. The long superheating, with the charge relatively high in manganese, and the basic slag, brings the sulphur to 0.04 to 0.07 per cent. Phosphorus runs about 0.30 per cent.

By adjustment of composition, tensile strengths of 60,000 lb. per sq. in. in the lighter castings, and 40,000 lb. per sq. in., or better in the heaviest ones are obtained, with very good uniformity of strength between the outside and the heart of even the heaviest castings. In this range of strengths, all the castings are readily machineable, with fine graphite and a pearlitic matrix, the structure of Figs. 1 and 2 being characteristic of that aimed at in all sizes of castings. The samples for structure were taken from a 4.5-in. section.

As it is strength and structure rather than a particular composition that are sought, we have given the name "Cecolloy" to our group of compositions, which are varied according to the section to be cast.

Board Drop Hammer Frame. Weight is 7,800 lb.

The Embrittlement of Boiler Steel—II

A Correlated Abstract[*]

BY EVERETT P. PARTRIDGE AND W. C. SCHROEDER

The Effect of Chemical Attack on the Mechanical Properties of Low-Carbon Steel

IN THE FIRST PART of this survey, the chemical reaction between iron and water and the effect of various dissolved substances upon its rate were considered. Attention will now be directed to the effect of chemical attack, unaccompanied by stress, upon the mechanical properties of steel as determined by tests subsequent to exposure. Since hydrogen is the inevitable product of contact between steel and water, its effect will be considered in some detail in addition to that of substances in solution in the water.

Hydrogen Embrittlement

STEEL which has been pickled in sulphuric acid shows very little, if any, loss in tensile strength,[26, 27, 28, 29], but its ductility is markedly reduced. In tension tests the elongation may be as low as one-sixth of the normal value,[28] and the fracture is characteristic of a brittle material. Pickled steel cracks after a smaller number of repeated bends than does the same steel before pickling.[26, 27]

Diffusion of Hydrogen

The brittleness of steel as a result of pickling is apparently due to hydrogen which has diffused into the metal. Fuller[30] studied this diffusion in some detail with seamless iron tubes, closed at the bottom and equipped at the top with a calibrated tube for measuring gas volumes. The apparatus was filled with mercury and immersed in water or aqueous solutions. Hydrogen gradually collected in the calibrated tube, both when the steel was made the cathode and in the absence of any external electrical potential. Since tests definitely proved that no acid penetrated to the interior of the tube, this hydrogen must have originated at the outside of the tube and diffused through the metal wall. This same process of diffusion previously had been studied by Winkelmann[31] with a similar apparatus in which an iron tube was made the cathode in a 1 per cent solution of sodium hydroxide. When Bardenheuer and Thanheiser[32, 33] made a heavy steel bomb the cathode in an electrolytic cell, they were able to measure pressure as high as 300 atmospheres within the bomb caused by the diffusion of hydrogen through the steel wall. All of these investigators[30, 31, 32, 33], noted that the rate at which hydrogen diffused through steel increased with increase in temperature. In this connection it may be noted that the velocity of diffusion of hydrogen through iron has been found [34] to increase suddenly at about 390 deg. F. (200 deg. C.).

Bardenheuer and Thanheiser[32, 33] also discovered that when hydrogen was produced in the chemical reaction of sulphuric acid at a steel surface, although the rate of diffusion increased with temperature, there was a decrease in the ratio of hydrogen diffused to hydrogen evolved. Their observation, that inhibitors which decreased the rate of deposition of atomic hydrogen correspondingly decreased the rate of diffusion, has been checked by Morris,[35] who also found that a trace of sulphur dioxide very greatly increased the rate of diffusion as compared with the rate of evolution.

The part played by impurities in producing hydrogen embrittlement has been debated at some length since Körber and Ploum[36, 37] showed that pure iron reacted with pure sulphuric acid only at a very slow rate and did not absorb any appreciable quantity of hydrogen, but that the presence of small amounts of sulphur or arsenic compounds increased the hydrogen absorption. Alexejew and his co-workers[38, 39] have supported the theory that hydrogen is transferred to the metal only through hydrides as intermediary agents, while Krassó[40] has attributed the effect of impurities to the changes they produce in the over-voltage necessary for hydrogen evolution at the metal surface. Although this question is primarily of academic interest, further investigation may reveal information of practical significance. For the present discussion, the fact that low-carbon boiler steel contains impurities quite adequate to promote hydrogen absorption will suffice.

State of Hydrogen in Steel

Whether hydrogen released by chemical action at a steel surface as atoms remains in the more reactive atomic form while diffusing through the steel, or whether rapid combination to molecular form takes place prior to or during diffusion has been a matter of scientific argument, with evidence supporting the first alternative supplied by Bodenstein,[41] Bonhoeffer[42] and Morris,[35] among others. Fuller[30] proposed that the hydrogen atoms diffused readily into the steel, in the interior of which combination to form hydrogen molecules took place. Since these could escape by diffusion only at a slower rate, a pressure sufficient to force them through the metal would be built up. In discussing this hypothesis, D. A. MacInnes suggested that instead of atomic hydrogen diffusion through the metal, it was more likely that hydrogen atoms combined at the surface into molecules which were forced through the steel by the presence of a high degree of supersaturation, corresponding to a high gas pressure, in the layer of solution in contact with the steel.

Edwards[43] performed some interesting experiments with 3-in. discs of thin plate, hot rolled to yield two layers of steel separated by a layer of oxide, and welded around the edges. When these were pickled in acid, hydrogen diffusion into the metal caused separation of the layers, some specimens bulging a quarter of an inch. Blisters formed on thin sheets during pickling were accordingly attributed to the presence of inclusions analagous to the oxide layer. Edwards suggested that hydrogen atoms diffused into the steel by transfer from one iron atom to another until, at a discontinuity such as an inclusion, the atoms combined to form molecular hydrogen which, being unable to diffuse out of the metal as rapidly as it was formed, accumulated until the pressure was sufficient to rupture the steel. Bardenheuer and Thanheiser[32] have agreed with this viewpoint, and Morris[35] has shown that a coating of oxide on the dry side of a steel plate retards the rate of diffusion of hydrogen produced by chemical reaction at the opposite surface.

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[*] Published by permission of the Director, U. S. Bureau of Mines. (Not subject to copyright.) This summary has been prepared in connection with an investigation conducted under a cooperative agreement between the Joint Research Committee on Boiler Feed Water Studies and the United States Bureau of Mines. The general investigation is supervised by a subcommittee of which J. H. Walker is chairman, and is carried out at the Nonmetallic Minerals Experiment Station of the Bureau of Mines, maintained in cooperation with Rutgers University at New Brunswick, N. J. The interpretations and comments in this summary are those of the authors, and the summary as a whole is to be regarded as a report to the subcommittee rather than by the subcommittee.

The first part of this correlated abstract appeared in the June, 1935, issue of METALS & ALLOYS. The authors are, respectively, supervising engineer, Nonmetallic Minerals Experiment Station and research chemical engineer, Joint Research Committee on Boiler Feed-Water Studies, attached to the Nonmetallic Minerals Experiment Station, U. S. Bureau of Mines, Rutgers University, New Brunswick, N. J.

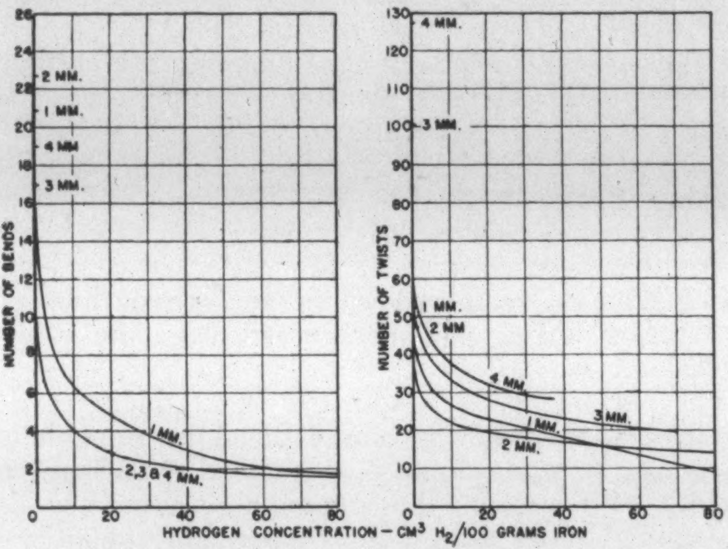


Figure 6—Relation between Hydrogen Concentration and Brittleness of Iron Wire (Bardenheuer and Ploum).

The Solubility of Hydrogen in Iron

The amount of hydrogen which iron will dissolve increases with increase in temperature or pressure. Sieverts[44] has determined the solubility at temperatures above 770 deg. F. (410 deg. C.) under pressures near that of the atmosphere, but no measurements are available at lower temperatures and higher pressures. At 770 deg. F. (410 deg. C.) the solubility is only 0.4 cu. cm. of hydrogen per 100 grams of iron. Extrapolation of Sieverts' data to room temperature and one atmosphere pressure would indicate a scarcely measurable value.

The amount of hydrogen actually present in iron at ordinary temperatures may be increased far above the equilibrium solubility value by two means. One is the liberation of hydrogen at the metal surface by chemical action or electrolysis, the other, quenching after exposure to hydrogen at an elevated temperature. In the first case the hydrogen is produced as a result of the application of an electrochemical potential which is equivalent to a very high gas pressure; in the second, the greater amount of hydrogen dissolved at the higher temperature does not escape as rapidly as the iron is cooled. Employing both of these methods, Bardenheuer and Ploum[45] were able to produce samples of steel containing at room temperature as much as 80 cu. cm. of hydrogen per 100 grams of iron.

Relation Between Hydrogen Concentration and Brittleness

In most of the investigations concerning hydrogen embrittlement nothing was known concerning the amount of hydrogen actually taken up by the steel. Heyn[46] found that hydrogen gas at atmospheric pressure did not produce brittleness in steel unless the temperature exceeded 1350 deg. F. (730 deg. C.). From the solubility measurements of Sieverts,[44] the concentration of hydrogen at this temperature would be close to 2 cu. cm. per 100 grams of steel. By combining these two pieces of information, Bauer[47] deduced that this concentration represented a limiting value below which embrittlement would not be produced.

A more definite quantitative relation between dissolved hydrogen and embrittlement has been supplied by the work of Bardenheuer and Ploum.[45] These investigators used bending and torsion tests to measure the brittleness of specimens of 0.04 per cent carbon steel wire containing different concentrations of hydrogen. From Fig. 6, which reproduces their curves, it is evident that the introduction of a very small amount of hydrogen greatly reduced the ductility as measured by either test.

Recovery of Steel from Hydrogen Embrittlement

In addition to the knowledge that hydrogen diffuses through steel, and that when steel absorbs hydrogen it becomes brittle, there is the further evidence that removal of the hydrogen removes the brittleness to a considerable degree, if not entirely. For example, Ledbur[26] noted that pieces of iron wire embrittled by contact with zinc in dilute sulphuric acid had lost their brittleness after standing for four weeks in air at room temperature. Coulson[27] found that the physical properties of his specimens embrittled by cathodic pickling were completely restored by annealing and partially restored by anodic pickling. Langdon and Grossman[48] discovered that, while the brittleness of pickled steel decreased slowly on standing at room temperature and rapidly on heating in air in an oven at 212 deg. F. (100 deg. C.), the maximum recovery in the latter case left the metal still less ductile than the original material before pickling. They observed, however, that a brittle specimen boiled in water regained its ductility in from 2 to 10 min., in some cases almost completely. Bardenheuer and Ploum[45] noted that the recovery of ductility accompanying loss of hydrogen was incomplete in all cases and that rapid removal of hydrogen by heating at 750 deg. F. (400 deg. C.) did not yield as good recovery as removal by slow diffusion at room temperature. Pfeil[28] found it desirable to conduct his tensile tests while the steel was subjected to pickling conditions, as the effect of hydrogen disappeared rapidly after the pickling was stopped, presumably due to the elimination of the hydrogen by the cold working of the steel. This effect of cold working has been substantiated by Bardenheuer and Ploum.[45]

The fact that the removal of absorbed hydrogen does not completely restore the original ductility of steel points toward some permanent change in the metal. This has also been demonstrated by the measurements of Reber[49] on the magnetic properties of iron made the cathode in sulphuric acid or potassium hydroxide. Exposure for several hours produced a magnetic "hardening" of the initially "soft" steel which could not be removed by long storage in air at room temperature or by annealing for 17 hrs. under vacuum at 552 deg. F. (400 deg. C.). This permanent change in magnetic properties was ascribed to local cold-working of the iron as a result of internal stresses set up by hydrogen absorbed in excess of the normal solubility. This method of investigation would presumably be more sensitive than the metallographic and X-ray methods employed by Alexejew et al.,[38] who could observe no change in the structure of steel due to the absorption of hydrogen.

Mode of Failure of Hydrogen-Embrittled Steel

Steel which has absorbed hydrogen tends to crack in a brittle manner along grain boundaries instead of first deforming by movement of individual crystals along slip planes and then failing by transcrystalline fracture. This change might conceivably be due either to a weakening of the grain boundaries or to an increase in the resistance to movement along slip planes. The work of Pfeil[28] with test pieces ranging from single crystals to material of the ordinary finely crystalline structure has indicated that absorption of hydrogen produces both a marked weakening of the intercrystalline boundaries and a decrease of the cohesion across the cubic cleavage planes, but does not affect the movement along slip planes. This investigator observed an apparent tendency for the type of fracture to change from intercrystalline at temperatures of 77 to 95 deg. F. (25 to 35 deg. C.) to transcrystalline at 104 to 122 deg. F. (40 to 50 deg. C.). It is possible, however, that his test pieces at the higher temperatures actually contained less hydrogen, due to changes in the oxide coating on the steel or to more rapid diffusion of hydrogen out from the test piece. This is suggested by the fact that the elongation of the specimens at the slightly higher temperatures was nearly twice as great as at the lower temperatures.

Practically all of the specimens showed a number of short, shallow cracks approximately at right angles to the axis of the specimen. Pfeil has suggested that these originated as cleavage cracks in surface crystals so oriented as to present a cleavage plane at right angles to the stress. Since Körber and Ploum[36] and Bardenheuer and Ploum[45] have shown that the surface layers of a steel specimen contain a higher concentration of hydrogen than the interior, such cracking of surface crystals might take place while the metal on the interior was actually deforming plastically under load.

Suggested Mechanism of Hydrogen Embrittlement

The way in which the entry of hydrogen into steel causes it to become brittle and the subsequent removal of the hydrogen causes the steel to recover to a considerable extent its original ductility is still a matter of uncertainty. Considering separately the large temporary effect and the smaller permanent effect of hydrogen upon steel, the experimental evidence may be tentatively summarized as follows.

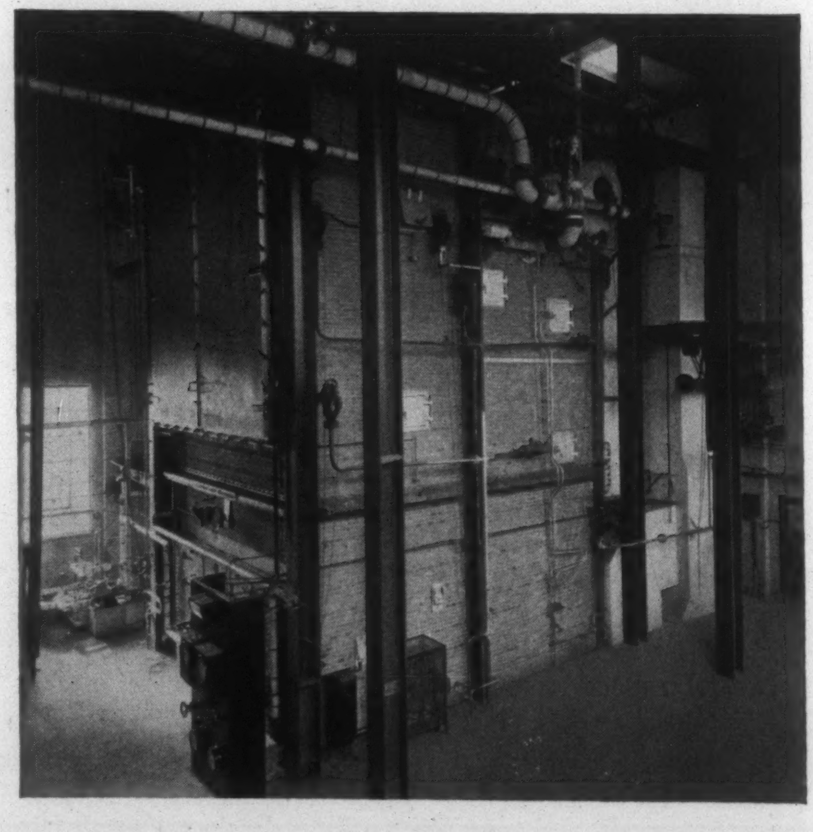
The *temporary* effect is apparently due to internal stresses set up by hydrogen absorbed in excess of the normal solubility at any given temperature and pressure, these stresses tending to produce failure both of the boundaries between crystals and along the cleavage planes within crystals.

The *permanent* effect may be due to several causes. In the first place, residual strains may be left in the steel as a result of the internal stresses set up by the absorbed hydrogen. In the second place, it is possible that permanent changes in the steel may be produced by chemical reaction of the hydrogen with the compounds of such elements as sulphur, arsenic, or carbon present in the metal. That oxides would be reduced by hydrogen passing through the steel, as postulated by Williams and Homerberg, [50] seems unlikely, however, in view of the evidence in the first part of this summary that the reaction proceeds rapidly in the opposite direction, iron removing oxygen from water and forming a coating of oxide with the simultaneous liberation of hydrogen.

It is known that the carbon combined in steel may be removed at a fairly rapid rate by reaction with hydrogen at high temperatures. That this decarburization also takes place, though more slowly, in the range from 300 to 520 deg. F. (150 to 270 deg. C.) when the hydrogen is under very high pressure has been shown by Inglis and Andrews.[51] Decarburization would tend to weaken the structure by producing fissures at grain boundaries initially rich in carbide, as well as by converting pearlite into ferrite.

Too much emphasis cannot be placed on the fact that serious brittleness due to hydrogen may exist while the hydrogen is being produced by chemical action at the surface of the steel, but may disappear very rapidly and almost completely when the reaction to produce hydrogen ceases. The same piece of steel within a period of a few hours may become brittle as a result of the absorption of hydrogen, and then, through some slight change in conditions, may again become ductile as a result of losing the hydrogen.

Four important considerations stand out from this examination of the question of hydrogen embrittlement. Hydrogen in steel does not seriously affect the tensile strength. Very low concentrations of hydrogen are sufficient, however, to produce marked brittleness. This brittleness disappears more or less completely if the hydrogen leaves the steel. Concentrations of hydrogen greatly exceeding the limiting solubility of steel, and well above the value necessary to produce serious brittleness, may be produced by chemical action at the surface of the metal.



Caustic Embrittlement

IF hydrogen is directly responsible for the embrittlement of steel pickled in sulphuric acid, the suspicion cannot be avoided that it is also the agent, or at least one of the important agents in the embrittlement of steel by hot, concentrated solutions of sodium hydroxide. Such solutions have the property in common with dilute sulphuric acid of attacking the protective oxide coating on steel. Both sulphuric acid and sodium hydroxide thus tend to accelerate the rate at which hydrogen is formed by allowing water to come in contact with steel more rapidly than would otherwise be possible. It would not be surprising, therefore, to discover some similarity between the behavior of steel pickled in sulphuric acid and steel exposed to concentrated caustic solutions, particularly at elevated temperatures. The possibility of direct attack by the sodium hydroxide upon impurities segregated at grain boundaries must also be kept in mind.

Some data procured at ordinary temperatures by Fuller[52] may be cited, although they refer to a steel containing 0.35 per cent carbon and 3.5 per cent nickel which had a tensile strength of 110,000 lb. per sq. in. When this steel was subjected to fatigue tests in a rotating-beam machine under a maximum stress of 90,000 lb. per sq. in., from 105,000 to 141,000 cycles were required to cause fracture. Two pieces pickled for 1 hr. in 10 per cent sulphuric acid and tested immediately failed in 62,000 and 66,500 cycles, respectively. A considerable part of this reduction in life was probably due to surface pitting of the steel by the acid. The fact that two other pieces pickled in the same manner but subsequently heated for 4 hrs. at 266 deg. F. (130 deg. C.) broke only after 74,400 and 76 800 cycles indicates, however, that brittleness resulting from absorption of hydrogen may have contributed to the failure of the specimens tested immediately after pickling.

Pitting was obviated in two other tests by making the steel specimen the cathode for 24 and 48 hr. respectively in a cell containing 5 per cent sodium hydroxide. The failure of these pieces during subsequent fatigue tests occurred after 78,100 and 82,400 cycles. The decreased life in this case, as compared with the original untreated steel, may be attributed primarily to embrittlement by hydrogen, since surface corrosion was minimized.

In some cases the evidence is in conflict. Thus Werner[53] states that steel which had been treated as the cathode in 10 per cent sodium hydroxide showed no loss in notch toughness or in ductility as measured by bending tests. Lea,[54] on the other hand, found that specimens made the cathode in 10 per cent sodium hydroxide showed typical brittle failure during subsequent tensile tests although the tensile strength was not affected. He observed the interesting fact that a specimen polished with great care was not embrittled. In repeated torsion tests round test pieces exposed to sodium hydroxide showed greater endurance than similar pieces in air, but the final fractures in the former case were typical of a brittle material.

Small test bars of wrought iron submerged in a "concentrated" solution of sodium hydroxide on the steam bath for periods of 7 and 20 days respectively were found by Andrew[55] to be brittle, although discs of wrought iron and 0.5 per cent carbon steel similarly treated for 104 days showed no brittleness. These experiments were only of a qualitative nature. Grain growth in the metal during exposure to hot sodium hydroxide solutions, reported by Andrew, has never been found by any subsequent investigator.

Merica [56] in his work with Parr[57] used test pieces of ¼-in. 0.18 per cent carbon annealed steel wire which were sealed in bombs with a solution containing 544 grams of sodium hydroxide per liter. The bombs were maintained at temperatures of 212, 356 or 536 deg. F. (100, 180 or 280 deg. C.) for periods of from 3 to 30 days. After exposure in the bombs, the test pieces were machined down with the removal of from 15 to 20 per cent of the metal and were then tested in tension, impact, and alternate bending by rotation at 120 r.p.m. The yield point and tensile strength were found to be practically unaffected.

No consistent trend can be deduced from the impact tests. The number of cycles required to produce failure in the alternate bending test was, however, reduced on the average by about 20 per cent in two series of tests run chiefly at 180 and 280 deg. C. (356 and 536 deg. F.) A third series of tests at 200 deg. C. (392 deg. F.) gave apparently contradictory results, four out of five samples exposed to the stated concentration surpassing the original metal. The machining operation between exposure in the bombs and testing may well have eliminated any effect of hydrogen.

During their studies of the reaction of iron with various solutions at elevated temperatures, Berl, Staudinger and Plagge[58] exposed unstressed steel rods to various concentrations of sodium hydroxide at a pressure of 100 atmospheres (1470 lb. per sq. in.), corresponding to temperatures somewhat above 590 deg. F. (310 deg. C.). After 14 hr. in contact with the solution, during which a pressure of from 18 to 25 atmospheres of hydrogen was developed, the test pieces were removed from the bombs and subjected to tensile tests. Although the tensile strength was practically unaffected, the elongation was consistently lowered, with the exception of specimens exposed to a concentration of 620 grams of sodium hydroxide per liter, which showed values approximating those for the original untreated steel. Some additional measurements made by Berl and van Taack[59] indicated that the decrease in elongation produced by exposure to solutions containing 300 grams of sodium hydroxide per liter could be offset to some extent by the addition of 70 grams of sodium sulphate or comparatively small amounts of potassium chromate per liter.

One of the characteristics of embrittlement due to hydrogen is the recovery of ductility on standing in air. This phenomenon was reported in two cases cited by White and Schneidewind.[60] In the first case a low-carbon steel tube from a caustic soda evaporator cracked 1.5 in. below the tube sheet after having been in service about one year. When the tube was removed it was exceedingly brittle, but after being exposed to the air for some time its ductility returned. In the second case a wrought iron strap failed after being exposed for five weeks to a solution at 140 deg. F. (60 deg. C.) containing 55 per cent of commercial trisodium phosphate. The uncracked portion of the metal regained its ductility after standing in the air.

Further consideration of embrittlement in evaporators and other equipment handling hot solutions of caustic soda will be postponed to a later section of this summary, since stress in conjunction with chemical attack appears to have played some part in the majority of failures reported. The rather scattering experimental evidence cited in the present section points to the interesting possibility that hydrogen is the active agent in the embrittlement of steel by sodium hydroxide, as originally suggested by Parr.[57]

Corrosion

Hydrogen can be a factor in the embrittlement of boiler steel only as the result of a chemical reaction beween the steel and the boiler water or a saline solution derived from it by concentration in a seam. In addition to any effect of hydrogen, the actual corrosion of the steel must be considered. It is conceivable that a brittle condition might be produced in steel by a highly selective corrosion proceeding through the material along the grain boundaries. Indeed the fact that some intercrystalline cracks in embrittled boiler steel were found to be filled with oxide has been mentioned by Rawdon[61] as possible evidence of direct selective chemical attack. In such a case it would seem difficult, however, to decide whether direct preferential oxidation at the grain boundaries produced the brittle condition, or whether hydrogen embrittlement caused separation of the boundaries, allowing water to enter with the resultant formation of the observed oxide. Perhaps the truth lies between the two extremes.

Williams and Homerberg[50] observed that artificially produced sulphide inclusions were attacked by sodium hydroxide. Hot concentrated solutions of this substance would also tend to attack oxides, as noted in the first part of this summary. There appears to have been no certain experimental distinction, however, between the two possibilities of indirect effect of chemical reaction in the form of hydrogen embrittlement, and the direct effect in the form of selective corrosion at grain boundaries.

Corrosion Fatigue

Whether or not actual intergranular corrosion of low-carbon steel takes place, corrosion so localized as to produce pits may be important in causing the failure of boilers. Steel under load is subjected to a concentration of stress at any abrupt change in section. Under a steady load this stress concentration is comparatively unimportant as long as the elastic limit is not exceeded. Under repeated loading or a reversal of stress, however, the steel may fail in fatigue even though the average stress is well below the elastic limit. That corrosion pits on the surface of steel may act as points of stress concentration at which fatigue cracks start has been demonstrated by a number of investigators. McAdam particularly has made a detailed study of the inter-related effects of corrosion and cyclic stress which will be discussed in a later section of this summary. For the present, it is only necessary to emphasize the ideas that any type of non-uniform chemical attack upon steel subject to changes in stress introduces potential danger from fatigue, and that, in general, the possibility of fatigue failure increases as the chemical attack becomes more highly localized with the production of sharper and deeper pits.

Conclusions

Because hydrogen is inevitably produced whenever water comes in contact with steel, particular attention has been directed in the preceding sections to the brittleness produced in steel by dissolved hydrogen. From a consideration of experimental results the following general conclusions are offered:

1. The normal solubility of hydrogen in iron over the range of boiler temperatures is estimated to be very low. The solubility in general increases with temperature and with pressure.
2. Quantities of hydrogen greatly in excess of the ordinary solubility may be absorbed by steel during chemical reaction at the surface of the metal, the hydrogen diffusing readily into the metal as if it were under an extremely high gas pressure.
3. Hydrogen absorbed by steel during chemical reaction at the metal surface diffuses out of the steel when the chemical reaction ceases.
4. The rate of diffusion of hydrogen through steel, both into the steel during chemical reaction at the metal surface and out from the steel after reaction has stopped, increases with temperature.
5. Steel which has absorbed hydrogen behaves in a brittle manner, both the elongation and the number of bends required to produce failure being markedly decreased, although the tensile strength is practically unaffected.
6. Steel which has been embrittled as a result of the absorption of hydrogen regains its ductility when the hydrogen is removed, but the recovery is generally incomplete. The permanent impairment in properties may be due to strain set up in the metal or to reaction of the hydrogen with some of the minor constituents in the steel.
7. Only a low concentration of hydrogen in steel, much below that which may be produced by chemical reaction, is necessary to cause brittleness.
8. Whether or not a specimen of steel will be embrittled by an aqueous solution may depend largely upon the degree to which the solution removes or prevents the formation of the protective coating of oxide on the metal surface.
9. Direct intergranular corrosion of steel by a boiler water or its concentrated saline may be possible, but has never been definitely demonstrated.
10. Selective corrosion of steel subjected to repeated or reversed stresses may lead to ultimate failure by fatigue.

(To be continued)

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Atmospheres for Annealing High Brass in Relation to Buffing

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IN MANY OF ITS USES, BRASS sheet and strip must be given a high polish for decorative effect. This is accomplished by buffing, which may be done upon the sheet when flat articles are to be stamped out of the sheet or upon a finished article that has been pressed or drawn. In either case the amount of material that has to be removed, before a truly bright surface is obtained, affects the cost of buffing.

Different Layers to be Removed

In the high zinc brasses, commercially termed "high brass," the usual anneal and pickle leaves a thin layer, which has still to be removed by buffing. This layer is rather loose and softer than the underlying material and, with ordinary pressure and speed of the buffing wheel and the ordinary polishing material used, the brass will lose weight continuously during the buffing operation while the layer is removed. It, however, approaches a near constant weight, not practically diminished by further buffing, when the soft and loose layer is all removed and full polish required. Hence, the amount of this layer can be followed experimentally by weighing a specimen after full polishing.

The soft and loose layer is doubtless altered both in chemical composition and in physical structure from the brass beneath. The soft, matte layer might be ascribed to dezincification, either through volatilization of zinc from the surface during annealing, or through selective solution of zinc during pickling. Probably both factors enter and the degree of dezincification by volatilization will doubtless affect the way the acid attacks the surface in pickling. The volatilization from the surface will be controlled by the time and temperature of annealing and by the freedom with which the zinc can escape to the furnace atmosphere.

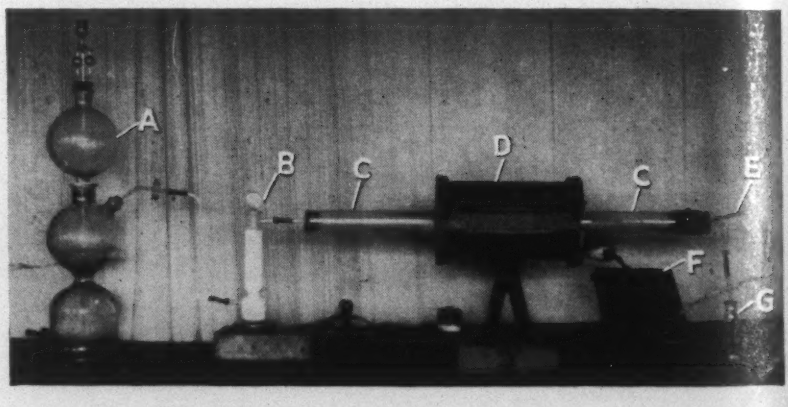
Theoretically, the rate of volatilization would be controlled to a large degree by the partial pressure of zinc in the atmosphere surrounding the specimen, but this is considerably modified by any mechanical barrier, just as in the case of a pot of molten brass containing a little aluminum. If the aluminum oxide skin is unbroken the pot does not fume, but if it is broken it does fume. Hence, the nature of the furnace atmosphere and that of any scale or deposit, such as soot, that is formed between the metal and the atmosphere, may play a considerable part in the rate of zinc loss from the surface.

Increase in temperature may have three effects: It may alter the rate of zinc loss from the surface, the type of scale or deposit formed, and the rate at which zinc diffuses from the body of the specimen towards the surface to replace that lost by volatilization.

Difference Between "Loose" and "Soft" Layers

What we termed the "loose layer" is of a different character than the soft layer referred to in the above paragraphs. It will be shown for instance that, on using uncracked city gas, there is formed on brass stock a loose layer of carbon, or, if such gas is not decidedly sulphur free, a copper and zinc sulphide layer appears. Further, here is always left on the stock residual oxides that are of such a nature as not to be removed chemically or physically in a pickling and wiping operation.

In a casual appraisal of bright annealing processes, one might draw conclusions from the appearance of the sheet and consider that the lack of scale or stain was a sufficient criterion of a satisfactory result, but a true appraisal of the process for buffed high brass must also take into account the cost of the complete sequence of operations of annealing, pickling and buffing. When the material is to be tinned or plated rather than buffed, all cost factors, to the point where the material is put in proper condition to take a good coating, have to be considered.



Aoparatus Used in Making the Tests on Atmosphere for Annealing High Brass

A—Gas Generator
B—Calcium Chloride Drying Tower
C—Pyrex Glass Tube (Annealing Chamber)
D—Electric Furnace
E—Thermocouple
F—Pyrometer
G—Gas Outlet

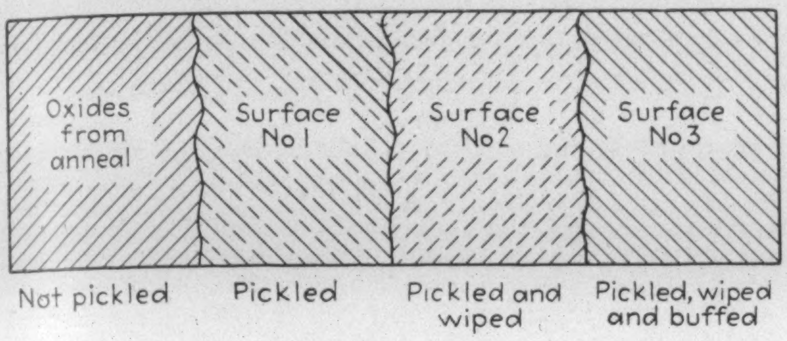
In order to appraise some of these factors in terms of buffing, laboratory experiments were carried out by using high brass of 65.75 per cent copper, 0.01 per cent lead, 0.025 per cent iron and balance zinc. It was hard rolled to a reduction of 50 per cent and a gauge of 0.019. Annealing was carried out to produce a grain of 0.04 to 0.05 mm. This corresponds to 46,500 to 48,000 lb. per sq. in. tensile strength; 56 to 60 per cent elongation in 2 in.; Shore hardness (magnifyer hammer) of 14 to 15 and an Olsen ductility value (1 in. ball) of 480-500. Annealing for 3 to 4 hr. at 1020 to 1025 deg. F. in air in an electric furnace produces such grain size and properties in the material used.

Effect of Time and Temperature When Heating in Air

Using 0.019 in. stock which was pickled in 7 to 15 per cent H_2SO_4, washed and dried with alcohol and ether, annealed for the time and temperature stated, again pickled, washed and dried, and then buffed to constant weight, the following weight losses were found on buffing a 1-in. sq. specimen on both sides, i.e., the loss is for 2 sq. in.:

Annealing Time, hr.	Annealing Temp., deg. F.	Buffing loss, grams per 2 sq. in.	Grain size, mm.
4	1025	0.0008	0.045
20 4	980 followed by 1025	0.0017	0.050

Tests proved that a simple erasing action was all that was needed to get the desired buffing action. No compound was used.



Appearance of Brass Sheet Surfaces for Various Process Operations

On repeating the anneal at 1025 deg. on buffed samples, a further loss of 0.0006 to 0.0012 grams was found after each anneal. Olsen tests on specimens annealed but not buffed before drawing average 0.482, those buffed before testing averaged 0.495. The difference is inappreciable.

Tests were then made in duplicate, pulling a pair of specimens out as soon as they had reached the temperature stated, with the following results:

Temp., deg. F.	Av. buffing loss, grams per 2 sq. in.
825	0.0011
875	0.0011
925	0.0011
980	0.0013
1025	0.0013
1075	0.0017
1124	0.0017
1150	0.0018
1200	0.0018
1280	0.0020

The buffing loss increases with time and with temperature, but it will be noted, that the loss in the short time test of the second series at 1025 deg. shows a greater loss than that after 4 hr. at 1025 deg. in the first series. This might be explained by the lack of time for diffusion of zinc from the body of the metal into the surface layer in the second series. The second series by itself indicates the well known fact, that volatilization of zinc increases as the temperatures rises.

Effect of Atmosphere in Annealing Furnace

With this information on the buffing loss after annealing in air, attention was directed to the effect of the atmosphere of the annealing furnace. Tensile specimens of the same high brass as before (gauge 0.019) and 1-in. square specimens for buffing loss tests, were annealed in a laboratory tube furnace through which the gas to be studied was passed at the rate of 60 bubbles per min.

Using this experimental equipment, further tests were first made in air with bright rolled and dull rolled stock on which the surface was varied by the variations in the rolling oil used but the specimens were washed free from oil before annealing. Other specimens were annealed in air but coated with lard oil or mineral oil. Still other specimens after annealing and pickling, but before buffing, were exposed to hot damp air for 24 hr. and compared with those similarly treated but kept dry, to see if corrosion by water vapor had any effect. The buffing loss was unaffected by any of these variables, remaining at 0.0007 to 0.0009 grams.

It was expected that a prolonged pickle might alter the buffing loss, but specimens given the usual short pickle and one of 24 hr. gave the same loss of 0.0009 grams.

Since none of these variable had an appreciable effect, attention was then turned to variations in the atmosphere of the annealing furnace. Five different atmospheres were used as follows*:

1. Air (Oxidizing), (Dried with H_2SO_4).
2. Commercial nitrogen (Dried with H_2SO_4) containing traces of oxygen; supposedly neutral, actually slightly oxidizing, because of impurities.
3. City gas partly cracked. Reducing. (Dried with calcium chloride).
4. City gas (not cracked). (Dried with calcium chloride).
5. Hydrogen. Reducing. (Dried with H_2SO_4).

The analysis of this city gas was in per cent:

CO_2	1.0	H	24.8
Illuminants	2.0	CH_4	55.7
O	0.3	N	7.0
CO	2.8	Higher Hydrocarbons	6.9

Using a 2 hr. anneal, including a 30 min. soak, at 1025 deg. F., there was no perceptible difference in strength, elongation, hardness, Olsen test or grain size, no matter which atmosphere was used. All specimens fell within the limits previously mentioned.

The appearance of the surface (No. 1) as annealed but not pickled, and of the pickled surface after wiping (No. 3) was noted. Surface No. 3 is the one which must be removed by buffing. The surfaces showed the following:

Surface No. 1—Annealed, Not Pickled:

Air	heavy coating of oxides.
Nitrogen	light coating of oxides.
Cracked city gas	trace of oxides.
Hydrogen	no oxide coating.

Surface No. 2—Pickled but not Wiped:

This is not considered here.

Surface No. 3—Pickled and Wiped:

Air	Clear yellow. Contains some oxides undissolved by pickling.
Nitrogen	Darker than with air. Also contains some oxides not removed by pickling.
Cracked city gas	Darker than with nitrogen, stock decidedly dark colored—contains some oxides undissolved by pickling plus considerable carbon and sulphide.*
Hydrogen	Clear yellow, but brown at edges, roll gloss quite well preserved, only traces of oxides and sulphide.**

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* Sulphide from impurities in the city gas.
** Sulphide from contamination from rubber stopper.

The buffing loss on removal of surface No. 3 in grams per 2 sq. in. was:

Air	0.0010
Nitrogen	0.0014
Partly cracked city gas	0.0016
Hydrogen	0.005

The presence of carbon in the No. 3 surface when cracked city gas is used indicates that we did not succeed in cracking the city gas sufficiently, or that the gas penetrates the metal somewhat and is decomposed there. The occluded carbon may have interfered with pickling, at any rate the partly cracked city gas left the deepest layer to be removed by buffing. The hydrogen anneal best preserved the color and smoothness of the metal and left the least material to be removed by buffing.

It would appear probable that, of the annealing atmospheres tried, the ones that would put the material in the best condition for tinning or electroplating would be, in order of excellence: (1) Dry hydrogen, (2) air, (3) nitrogen, (4) city gas. It is, of course, possible that the presence of roll oil in the hydrogen anneal would give carbon troubles similar to those met with the city gas, and thus require the careful removal of oil before annealing. In air, the presence of oil is not harmful.

Letters to the Editor

Nickel in the Precious Metals Field

To the Editor: The writer would like to give nickel a boost in regards to its uses in precious metal cast alloys. Statements have been made in the November, 1934, issue of METALS & ALLOYS condemning nickel, due to its poor tarnish resistance when used in large quantities. The claim was that, if the gold plus platinum group metals falls below 75 per cent and the nickel content is over 2.0 per cent the tarnish resistance is seriously impaired.

Alloys have been fabricated during the year 1934 containing approximately 45 per cent gold, platinum, palladium plus 4.25 per cent nickel, the tarnish resistance being excellent. In fact the resistance was better than that of some alloys containing from 75 to 85 per cent precious metal.

Castings made from these alloys, low in precious metal content, have given very promising results and specimens are free from oxidation and porosity, a statement that cannot be made in connection with some alloys high in precious metal content. Physical characteristics further prove that these alloys are on the same level and in some cases well above other precious metal alloys listed in the hard class (Brinell No. approximately 195).

Due to the increase in price of gold, many alloys will appear on the market containing palladium, silver, copper, nickel, cadmium and zinc. Therefore, white alloys will replace the yellow in many applications.

ERIC H. SWANSON.

Prince Bay.
Staten Island, N. Y.

Nickel in Dental Alloys

To the Editor: Commenting on the letter from Mr. Swanson, of which you sent me a copy in advance of publication, my understanding of the matter is as follows:

Tarnish tests are so numerous and so difficult to evaluate that it is very seldom a unique experiment can be performed which will answer all questions on the subject. Dr. Harder's statement that nickel is used as a substitute for platinum and palladium is, I believe, correct. (METALS & ALLOYS, November, 1934, page 236).

Frequently, one hears of the tendency of nickel to irritate the tissues in certain mouths. I do not have data to show conclusive proof of this claim.

As you know, neither the government specifications nor the American Dental Association Specifications for dental alloys forbid the use of nickel in the dental alloys. However, in collecting data on tests of alloys submitted for use in the Federal dental laboratories of the Army and Veterans Administration, we have observed that alloys of approximately the same composition, except for the inclusion of a small amount of nickel (say 1 per cent) behave in a different manner from those free of nickel. Those having nickel were usually rejected because of low percentage of elongation. The nickel-bearing alloys, while strong in a sense, seemed to be "rotten" and lacked that resiliency so much needed by the dentist for cast clasps, three-quarter crowns and similar restorations. Undoubtedly, this defect in elongation could be corrected by a little study and experimenting.

I cannot agree that the gold-colored alloys will be replaced by white alloys. Already questions regarding the electromotive forces set up between the chromium (iron, cobalt, etc.) bearing alloys and previously placed gold alloys are being raised by the dentists. (Lain, *Journal* of the American Medical Assoc. March 11, 1933, page 717; also Nagle, Harvard Dental School). Remarkable physical properties have been developed in some of the special dental gold alloys. So resistant to tarnish and so superior in physical properties are some of these alloys that they are being considered for use in industry. The best dentists do not discard alloys because of the cost of the alloy. Cost of materials represents a small part of the charge for a high quality restoration.

Attempts to introduce nickel to the dental profession should be supported by proof of better physical properties and freedom from tissue irritation, either by electromotive force or idiosyncrasy of the individual. Data on all alloys should be on the as cast, as soldered, as vulcanized or wrought condition as used by the dentist.

Perhaps some of your readers would be interested in the type of tarnish test developed by Aaron Isaacs while at the Bureau for use in testing dental gold alloys. After cleaning, flat samples were polished with precipitated magnesium oxide paste, washed with dilute sulphuric acid, then washed with water and dried. The polished samples were then arranged around and outside of a beaker containing a strong solution of ammonium sulphide. The assembly was then covered with a bell jar and left four days at room temperature. (Samples placed in sulphide solutions may have the tarnish film dissolved by the solution, hence, the arrangements of specimens in the vapor and not in the solution.)

Rating the samples in terms of amount of tarnish is a difficult task and requires considerable care. However, when a sample appears no longer to show its original color as the predominating color, it may be rejected. Such dental alloys as were tested showed a break-down on tarnish somewhere around 65 per cent precious metal content. Since these alloys, if soldered, are usually soldered with lower carat solders, the value around 75 per cent precious metal content for basic alloys appeared to be necessary at the time the tests were made. This value can be reduced at any time it is shown that lower percentages are satisfactory in all respects. I have no proof that lower percentages are satisfactory in all respects at the present time.

WILMER SOUDER.

Chief, Dental Research Laboratory.
National Bureau of Standards

The Foundrymen's Toronto Convention

Arrangements are rapidly being perfected for the 1935 convention of the American Foundrymen's Association to be held at the Royal York Hotel in Toronto, Canada, Aug. 19 to 23. This is the first meeting in Canada since 1909. There will be no exhibit of foundry equipment and products this year but the convention will just precede the opening of the Canadian National Exposition. Major L. L. Anthes, a past president of A. F. A. and managing director of the Anthes Foundry, Ltd., Toronto, heads a large committee of Canadian foundrymen which is making extensive plans for the week's activities.

The tentative program of the leading technical and other events is as follows: Monday, Aug. 19, committee meetings; Tuesday, Aug. 20, sessions on cast iron, foundry sand research, sand shop course and cast iron shop course, the last two to be continued on Aug. 21 and 22; Wednesday, Aug. 21, sessions on malleable cast iron, materials handling and foundry equipment, cast iron metallurgy, foundry refractories and foundry costs and also one on silicosis and employer liability; Thursday, Aug. 22, sessions on apprentice training, non-ferrous castings, steel founding and cast iron with round table luncheons on steel, malleable, non-ferrous and gray iron castings; Friday, Aug. 23, sessions on steel founding, cast iron, dust control and safety codes and non-ferrous foundry. The annual business meeting is scheduled for the afternoon of Aug. 22 with the annual dinner and reception that evening.

The Institute of British Foundrymen exchange paper will be presented at one of the non-ferrous sessions by A. J. Murphy, metallurgist, J. Stone & Co., Ltd., Deptford, London. The paper will deal with high strength cast bronzes. Mr. Murphy is noted as the author and co-author of many papers before British technical societies.

2. ORE REDUCTION

A. H. EMERY, SECTION EDITOR

Primary Reaction of Metal Oxides with Solid Carbon (Über die Primärreaktion der Metalloxide mit festem Kohlenstoff). W. BAUKLOH & R. DURRER. *Zeitschrift für anorganische und allgemeine Chemie,* Vol. 222, Mar. 8, 1935, pages 189-200. The composition of the gas from the reduction of metal oxides with C was determined for various temperatures and pressures. Curves showing the volume of $CO \longrightarrow CO_2$ versus reaction temperature are given for Fe_2O_3, Fe_3O_4, FeO, MnO_2, Mn_2O_3, Mn_3O_4, MnO, NiO_2, Ni_2O_3, NiO, Co_3O_4, CoO, Cr_2O_3, ZnO, CuO, Cu_2O and SnO_2. In the reduction of mixed oxides both CO_2 and CO are products of the reaction and the percentage of each in the gas mixture is dependent upon the partial pressure of O_2 and the reducibility of the metal oxides. An oxide with a higher O_2 pressure or greater reducibility gives rise to a larger % of CO_2 in the reaction gas. Oxides with a reducibility comparable to Cu or Pb oxides give practically 100% CO_2. The fact that oxides such as MnO_2, freely give up their O_2 and oxidize the C primarily to CO_2 shows that the free burning of C in air should give primarily CO_2. The ease of reducibility of the various metal oxides studied is arranged in the form of a curve from which comparisons can be made. WB (2)

Briquetting of Flue Dust (Zum Brikkettieren von Flugstaub). E. T. RICHARDS. *Die Metallbörse,* Vol. 25, Jan. 25, 1935, pages 49-50; Jan. 19, 1935, pages 82-83. The addition of 2-3% $ZnSO_4$ to flue dust permits formation of hard briquettes, which do not disintegrate on storing and which resist hammering. Fe-sulphate with or without slaked lime yields extremely hard cakes even if molded by hand. $ZnSO_4$ decomposes at 720° C.into SO_3 and ZnO, the latter reentering the flue dust. In the presence of C, the binding ability of metallic Zn dust is greatly reduced. Briquettes containing a few % of lime and sal soda (+$ZnSO_4$ but no $FeSO_4$) can be handled in reverberatory furnaces if the flue dust contains much Pb or white metal. The briquettes added to blast furnace charges must be stronger and cause larger quantities of flue dust; there was no advantage in the use of binding materials containing CaF_2 as compared with pure lime or lime-soda mixtures. Excellent results were obtained with Portland cement with or without a small quantity of Fe-oxide (in order to lower the melting point), but the high price of this binding agent is objectionable; 10% cement is necessary for flue dust containing much C. Additions of ground Pb ores to flue dust high in Sn reduces the volatilization losses of Sn. If the flue dust contains larger amounts of S or As, scorification is facilitated by adding Na_2CO_3 or NaOH. Fe filings also are utilized to hold back As. If a briquetting machine does not furnish satisfactory results, sintering at 800°-1200° C. is recommended. EF (2)

2a. Non-Ferrous

Thermodynamic Data on Some Metallurgically Important Compounds of Lead and the Antimony-Group Metals and their Applications. CHARLES G. MAIER. *Progress Reports—Metallurgical Division 9. United States Bureau of Mines, Report of Investigations* No. 3262, Dec. 1934, 54 pages. Thermodynamic data for the compounds of Pb and the Sb group are presented, derived, and discussed, then applied to the problems of roasting galena-containing pyritic Au ores and to Pb softening. Assuming that contamination of Au particles in the roasting of auriferous pyrite is due to compounds of Pb, critical temperatures may exist for the filming of Au by Pb, PbS, or PbO from saturated vapor PbO does not exist in the roasted product, so far as thermodynamic considerations of the sulphate are concerned, but is due to mixing of roasted and unroasted ores at roasting temperatures. Excess air is not required and should be avoided to reduce filming. When PbO and PbS are present in the calcine, filming by metallic Pb may take place at temperatures above 616° for 14-mesh pyrite or 683° for 150-mesh. Thermodynamic calculations show the theoretical soundness of a countercurrent method of removing Sb from bullion. The steps of the proposed process are (1) low Sb bullion is treated with liquid $PbO.Sb_2O_3$ containing excess PbO, the mixture analyzing PbO 43.4-65%, forming a low-Sb bullion and Pb meta-antimonite, and (2) the latter is treated in batch process with high Sb bullion; Sb_4O_6 is volatilized and a low-Sb bullion formed for step (1), or, in place of (2), the Pb meta-antimonite is treated countercurrently with high-Sb bullion, producing softened Pb and a low-Pb slag which must be treated further to recover Pb. AHE (2a)

A Study of Drosses from Lead Blast Furnaces. GERALD U. GREENE. *American Institute Mining & Metallurgical Engineers, Contribution* No. 75, Feb. 1935, 20 pages. Drosses were analyzed and studied microscopically. Possible intermetallic compounds were made synthetically and their physical properties studied. The speisses formed were compared with the synthetic compounds. Final identification was made by X-ray methods. The compounds Fe_2As, Cu_3As, Cu_3Sb, and NiAs occurred in the speisses. Pb was present in the metallic state, and is associated principally with the compound Cu_3As. Pb is not soluble in Fe_2As and NiAs. Addition of scrap Fe to the furnace treating the dross, in larger quantities than that required for the PbS, is not beneficial. 6 references. JLG (2a)

Complete Mastering of Production of Alumina at the Volkhov Aluminum Plant. M. M. LABODA. *Legkie Metallui,* Vol. 4, Jan. 1935, pages 27-31. In Russian Formerly the charge consisting of 44% bauxite, 18% $CaCO_3$ and 38% Na_2CO_3 was calcined and Al_2O_3 extracted with H_2O at 25°. Due to poor results the charge was changed to 49% bauxite, 28% $CaCO_3$, and 23% Na_2CO_3 and the resulting calcine leached with Na_2CO_3 solution at 70°. The output of this plant in 1934 increased 90% over 1933, reaching 15,000 tons Al_2O_3; the cost decreased from 1317 to 903 rubles per ton, and the productivity of labor more than doubled. The analysis of the Al_2O_3 was 0.24% SiO_2, 0.04% Fe_2O_3, 0.08% CaO, and 0.40% Na_2O. HWR (2a)

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2b. Ferrous

Experiments on the Complete Reduction of Manganese Oxide in Molten Iron (Versuche zur restlosen Reduktion von Manganoxyd in flüssigem Eisen). E. DIEPSCHLAG. *Metallwirtschaft,* Vol. 14, Feb. 8, 1935, pages 107-110. In laboratory experiments Fe containing 4.57% C was melted in a graphite crucible and heated to 1650° C. Pure MnO was added to the melt and was completely reduced, resulting in Fe-C-Mn alloys containing 10 to 80% Mn. MnO is reduced by Fe and the resulting FeO is reduced by C, producing CO. Some of the Mn is lost by volatilization. The C content of the alloys increases due to absorption from the crucible, reaching 7.25% in the 80% Mn alloy. In further tests SiO_2 also was added. Both the MnO and SiO_2 were completely reduced and Fe-C-Mn-Si alloys with 1.5 to 7.1% Si were obtained. The Fe must be high in C and graphite crucibles must be used to reduce the MnO, otherwise a slag forms. 5 references. CEM (2b)

Electric-arc Reduction Furnaces for Production of Iron Alloys from Ores (Lichtbogen-Reduktionsöfen für die Herstellung von Eisenlegierungen aus Erzen). M. KAUCHTSCHISCHWILI. *Siemens-Zeitschrift,* Vol. 15, Feb. 1935, pages 44-50. Ferro-alloys are produced in arc furnaces. To produce 1 ton of FeSi one needs:

	for 45% FeSi	75% FeSi	90% FeSi
quartzite	1200 kg.	2200 kg.	3600 kg.
coke	600 kg.	1000 kg.	1500 kg.
scrap	500 kg.	250 kg.	50 kg.
electrical energy	5000-6000 kw.hr.	9000-11000 kw.hr.	14000-16000 kw.hr.
electrodes	30-40 kg.	60-80 kg.	110-130 kg.

FeW is made of wolframite (an Fe-Mn tungstate) or of scheelite (a Ca tungstate); energy consumption about 8000 kw.hr./ton. FeCr with about 0.8-1% C requires 7000-9000 kw.hr./ton if the Cr_2O_3 content of the ores is not less than 48-50%. A number of installations and operating data are described. Ha (2b)

Evaluation of Iron Ores (Die Bewertung von Eisenwerzen). W. LUYKEN. *Stahl und Eisen,* Vol. 55, Apr. 11. 1935, pages 419-421. After a discussion of the general bases of ore evaluation, the relation between the value and cost of various European ores is compared. SE (2b)

Physical-Chemical Basis for the Mixing of Iron Ores. Part II (Die physikalisch-chemischen Grundlagen der Möllerung von Eisenerzen. Teil II). J. KLÄRDING. *Archiv für das Eisenhüttenwesen,* Vol. 8, Feb. 1935, pages 325-328. Reduction experiments with pure $FeO\text{-}CaO\text{-}Al_2O_3$ indicate that the most favorable mixes lie at a 1:1 ratio of CaO to Al_2O_3. In homogeneous mixtures, dicalcium ferrite is not stable in the presence of Al_2O_3, at least over a wide range of compositions. Spinel appears as a stable phase up to high CaO contents and with low amounts of O in the groundmass. SE (2b)

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3. MELTING, REFINING AND CASTING

Flowability of Molding Sand. H. W. DIETERT & F. VALTIER. *Transactions American Foundrymen's Association,* Vol. 6, Feb. 1935, pages 199-210. Flowability of a molding sand is defined in this paper as the property which enables sand to flow when a ramming energy is applied. The greater the ease of flowing, the more readily will the sand form a continuous and uniform mold surface. The authors describe a test for flowability, which consists of measuring the movement of sand grains after an initial ramming. The relation of flowability to the other properties of sand is summarized as follows: It is increased by a decrease in moisture under the temper point, or increase above temper; by a decrease in clay content, in green sand strength, in green permeability, or an increase in grain fineness towards the finer grain materials. Flowability is decreased by the addition of sea coal to molding sand. CMS (3)

Control of Foundry Dust. R. J. ALDRICH. *Mill & Factory,* Vol. 16, Feb. 1935, pages 46-47. Deals with the installation of a dust control system in a modern foundry. Kz (3)

Propeller Patterns. STEPHEN E. SLOCUM. *Marine Engineering & Shipping Age,* Vol. 11, Mar. 1935, pages 107-108. Deals with specifications and methods of building propeller patterns. Kz (3)

Die-Casting. SAM TOUR. *Mining & Metallurgy,* Vol. 16, Feb. 1935, pages 82-85. From a paper presented before the Institute of Metals and Iron and Steel divisions of the American Institute of Mining Engineers, Oct. 3, 1934. Gives a survey of the die-casting industry from its beginning to the present time, and discusses some of the advances brought about in other industries and in other arts and sciences as a result of the die-casting industry. Intensive study of alloy steels to develop steels suitable for die-casting brought about the development of a Cr-V steel containing 2% Cr, a Cr-W steel of approximately 5% Cr, and a Cr-Mo steel of about 5% Cr and 1.5% Mo. Zn-base alloys now available show practically no tendency toward disintegration. Considers the die-casting of Cu- or brass-base alloys. VSP (3)

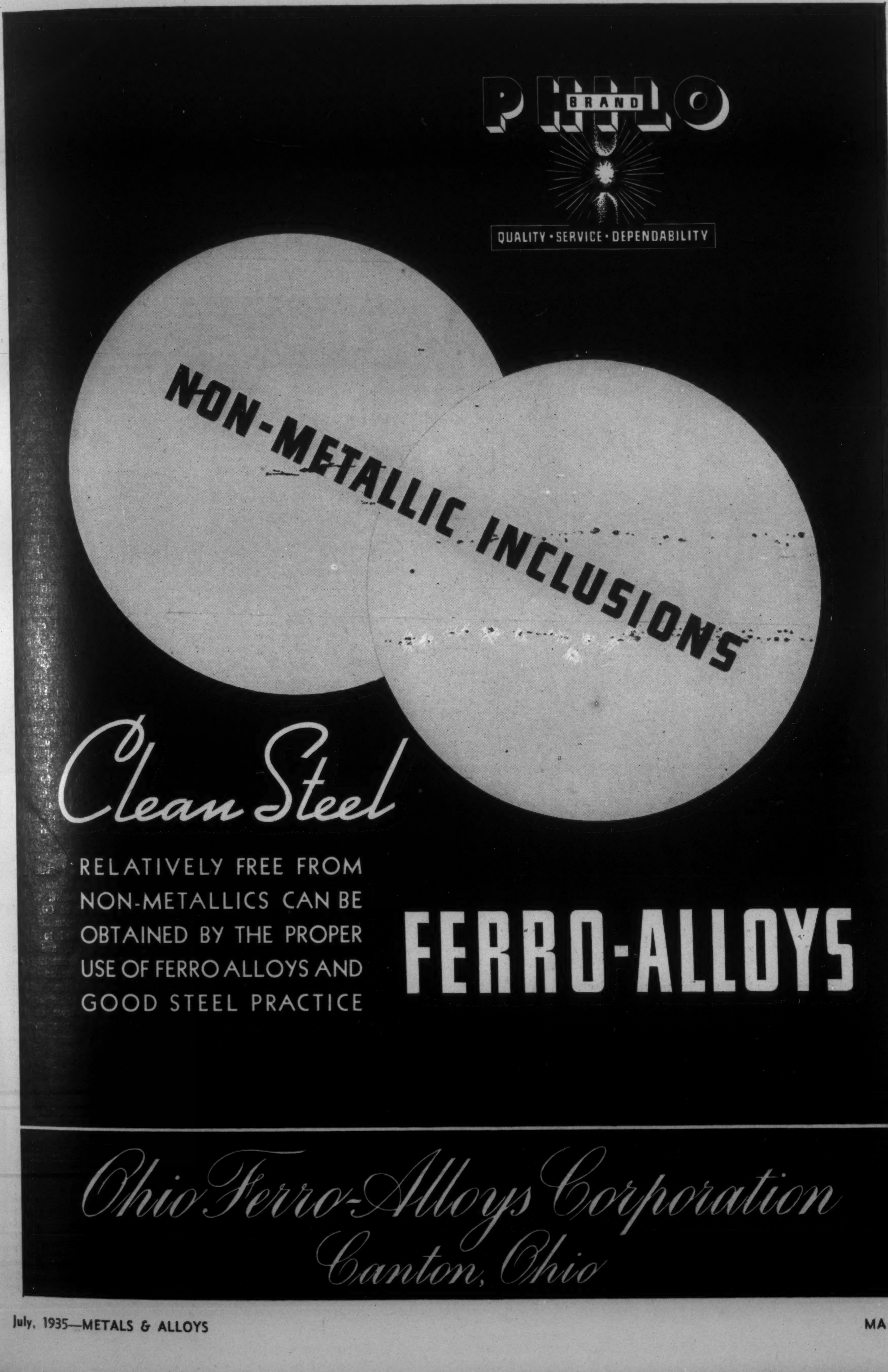
Latest Advances in Metal Refining and Their Significance for the Extension of German Raw Material Utilization (Über die neuesten Fortschritte auf dem Gebiete der Metallgewinnung in ihrer Bedeutung für die Verbreiterung der deutschen Rohstoffbasis). H. GROTHE. *Metall und Erz,* Vol. 23, Jan. 1935, pages 33-40. Description and discussion of the Renn process for enriching low grade Fe ores, the Magdeburg Zn electrolysis installation, the New Jersey Zinc Co.'s process for Zn refining, the Dörschel rotary reverberatory furnace for drying, roasting, volatilizing and melting, and the Gottschalk rotary furnace for Cu refining. 10 references. CEM (3)

3a. Non-Ferrous

G. L. CRAIG, SECTION EDITOR

Manufacture of Copper Tuyeres and Coolers. J. BLAKISTONE. *Foundry Trade Journal,* Vol. 52, Feb. 7, 1935, pages 113-114. This paper was read in the Short Paper competition held by the Middlesbrough Branch of the Institute of British Foundrymen. The paper describes briefly the system of manufacture of tuyeres and coolers. It is essential that the castings should be perfectly sound to stand test-pressure of 60 lbs. or more without any sign of porosity, and of pure Cu for heat conductivity and resistance to abrasion. The molten Cu is withdrawn from the furnace at a temperature of 1200° C. and cast at 1190° C. These temperatures should be strictly adhered to, as the slightest variation will result in an unsound casting. Phosphor-tin and phosphor copper are used as deoxidizers. If pit fires are used, the following charges are made: 112 lbs. of electrolytic copper; 1 lb. 6½ oz. of 5% phosphor tin; 4½ oz. of 15% phosphor-copper. The phosphor tin and copper are added after the pot is withdrawn from the fire, the metal being covered with charcoal. AIK (3a)

Improved Equipment and Alloys Lend Facility to Die Casting of Brass. CHARLES B. JACOBS, JR. *Steel,* Vol. 96, Mar. 18, 1935, pages 38-40. Development of die-casting machines such as those of Charles Pack and Joseph Polak has made possible die casting of brass. Both require a separate melting-pot. Either liquid or semi-molten metal can be cast in the former, while latter requires that metal be in plastic condition. Bottom of cup of Pack machine is formed by a plunger, and upper die is constructed so that it covers top of cup and also provides a gate into die. Alloy most suitable for general die-casting purposes contains 60% Cu, 1% Sn, 1% Pb, 0.10% Al, and remainder Zn. Pb increases plastic range and improves machinability. Al inhibits oxidation and reduces vaporization of Zn in holding pot. Sn increases fluidity, tends to inhibit segregation of Pb in holding pot when semi-plastic metal is being used, and increases corrosion resistance of casting. This alloy has a minimum tensile strength of 55,000 $lb./in.^2$ and elongation in 2" of 9%. Results of tests indicate that tensile strength of heavy sections is appreciably lower than that of lighter sections. Size of section affects ductility of cylindrical specimens very little, although flat sections have lower values. Increasing Pb content causes appreciable decrease in ductility and impact resistance. In general, die-cast alloys show superior tensile strength and lower elongation than standard sand-cast alloys. Certain high-Si alloys, such as Everdur are suitable for die-casting. MS (3a)



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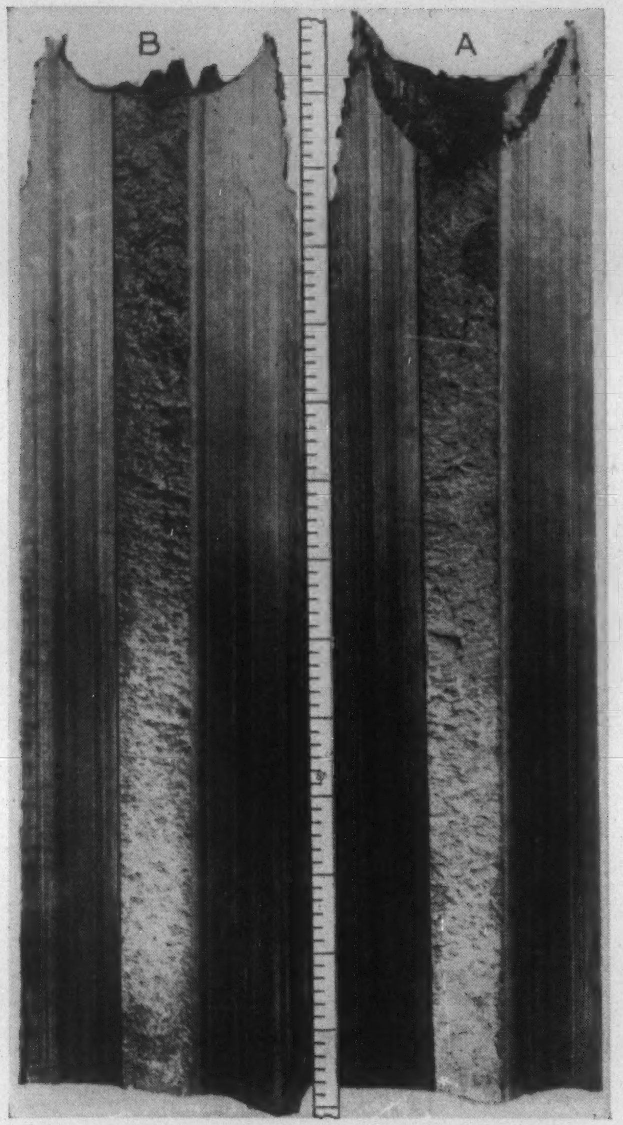

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Hydrogen Gives Sheath Quality. Lyall Zickrick. *Electrical World,* Vol. 105, Jan. 19, 1935, pages 30-31. Cable sheath quality is improved by keeping air away from the molten Pb. Air and its O may be eliminated or replaced by a deoxidizing atmosphere. H was used and the resulting sheath showed better quality and uniformity. CBJ (3a)

Die Casting of Brass. John R. Freeman, Jr. *Metals Technology,* Apr. 1935, *American Institute Mining & Metallurgical Engineers, Technical Publication* No. 615, 7 pages. Metals and alloys with lower melting points have been die cast for many years but the development of brass die castings has occurred within the past 5 years. Two types of machines are used—the Polak and the Pack. In both of these machines the alloy is forced into the mold while plastic. Brass die castings are practically free from visual internal cavities but do contain microscopic blowholes and shrinkage cavities. JLG (3a)

Preparation of Protactinium (Zur Herstellung von Protactinium). Aristid v. Grosse. *Berichte der deutschen chemischen Gesellschaft,* Vol. 68, Feb. 6, 1935, pages 307-309. In preparing 500 mg. of pure Pa, Graue and Käding used essentially the author's process. It is pointed out how several difficulties encountered by them in separating Pa from Zr and Ta could have been avoided and the process improved. CEM (3a)

Platinum Metals Which Settle During Gold Electrolysis and Industrially Important Gold Products (Über die bei der elektrolytischen Goldraffination anfallenden Platinmetalle und die für die Industrie wichtigsten Goldpräparate). K. Hessner. *Metall und Erz,* Vol. 23, Feb. 1935, pages 72-75. Details are given of the processes used to separate Au and the Pt group metals from the electrolyte and anode mud remaining from Ag electrolysis. The preparation of $KAu(CN)_4$ and other salt mixtures from metallic Au for Au plating purposes and the use of Au for gliding porcelain is described. 36 references. CEM (3a)

Remelting of Brass Scrap in Reverberatory Furnaces. Part IV. Melting Procedure (Das Umschmelzen von Messingschrott und -abfällen in Flammöfen. Teil IV. Schmelzverfahren). Karlheinz Herbert. *Die Metallbörse,* Vol. 24, Nov. 3, 1934, pages 1402-1403; Nov. 10, 1934, pages 1433-1434; Nov. 17, 1934, pages 1465-1466; Nov. 24, 1934, pages 1497-1498; Dec. 1, 1934, page 1531. Denies that brass dissolves O. A strongly reducing vapor layer of Zn forms over brass melts. ZnO is introduced into the melt by the oxidized scrap surface. Zn reduces all oxides (Sn, Fe, Ni, Cd, Sb, As, Pb) with the exception of P. The latter does not reduce ZnO but exerts a cleansing action by improving the fluidity. The effect of S, N and H is discussed. Stress is laid on the nature of the brass scrap remelted and especially on the pre-treatment of chips. Further points covered at length are the utilization of fluxes, temperature control, deoxidation (P is recommended) and casting procedure. According to the author's experiences, the utilization of reducing fluxes does not furnish exceptionally favorable results. Addition of powdered coke or charcoal to the slag and deoxidation with Cu-P shortly before casting yields the best results. If a sample taken from the melt exhibits porosity, additions of Pb-or Mn-oxide leads to solid castings. Al, Si and Fe can be easily removed from molten Cu but addition of Cu scale to brass melts is prohibitive. Sulphates of alkaline and alkaline earth metals are utilized instead. EF (3a)

Unsoundness in Aluminium Sand Castings. Part III.—Solidification in Sand Moulds Under Pressure. D. Hanson & I. G. Slater. *Journal Institute of Metals,* Vol. 56, Feb. 1935, pages 95-108 (Advance Copy No. 694). By allowing gassy Al alloy melts to solidify in sand molds under an extraneous pressure of air or N_2 pinholes were reduced in size and ingots of high density obtained. With most Al alloys a pressure of 50 lb./in.^{2} was sufficient to remove all visible traces of pinholes from a 2-in. diameter by 2 in. block. At higher pressures ingots having densities approaching the optimum were obtained. Heating the castings to different temperatures indicated that the applied pressure had operated to compress the pinholes to finer dimensions. The mechanical properties of the alloys were improved by solidification under pressure and shrinkage was confined to a single pipe. 4 references. JLG (3a)

Deoxidation and Degasification of Non-Ferrous Cast Alloys (Desoxydation und Entgasung von Nichteisengusslegierungen). *Die Metallbörse,* Vol. 25, Jan. 26, 1935, page 115. Critical discussion on the papers of Lorig and Ward before the American Foundrymens' Association, Oct. 1934. The overemphasizing of the effect of H and O in non-ferrous castings is refuted and the effect of CO, CO_2, N and H_2O is pointed out. It is denied that O occurs in the gaseous state in most of the liquid metals and alloys. Porosity can be only ascribed to O, if gases subject to oxidation are present as for instance H and CO, and if a smaller quantity of these gases is soluble in the solid state. Commenting on Ward's paper on the deoxidation of yellow brass, the strong deoxidizing action on Zn is pointed out and that the "deoxidation" of yellow brass actually represents a mechanical cleansing process, viz. the elimination of ZnO. P in particular improves the fluidity of the melt besides forming a protective gas layer on the surface of the liquid metal. Al, Si and Mn do not exhibit this phenomenon. Al_2O_3 is very difficult to remove. The conclusion of Ward that a reasonably low casting temperature offers the best method of degasification is questioned. EF (3a)

Melting of Non-Ferrous Alloys in Cupola-Type Furnaces (Das Schmelzen von Nichteisenlegierungen in kupolartigen Oefen). *Die Metallbörse,* Vol. 25, Jan. 19, 1935, page 82. Critical discussion on a paper of W. C. Alvin before the American Foundrymens' Association, Oct. 1934. EF (3a)

The Production of Refined Antimonial Lead Antifriction and Printers' Alloys. G. J. Brittingham. *Chemical Engineering & Mining Review,* Vol. 26, Aug. 6, 1934, pages 415-418. The antimonial slag, a by-product at the works of the Electrolytic Refining & Smelting Co. of Australia, Ltd., is regularly treated at Port Kembla for the production of antimonial Pb. This product is used in the manufacture of storage batteries. The antimonial slag together with fluxes and coke is fed to a blast furnace where most of the As is removed preparatory to forming a rough cast bullion which is subsequently refined and cast into ingots for market. The production of anti-friction bearing and printers' alloys from antimonial Sb, soft Pb, block, Sn, star Sb, and granulated electrolytic Cu is discussed. WHG (3a)

3b. Ferrous

C. H. HERTY, SECTION EDITOR

Bibliography of Non-metallic Inclusions in Iron and Steel. L. F. McCombs & M. Schrero. Mining & Metallurgical Advisory Boards, Carnegie Institute of Technology, Pittsburgh, 1935. Paper, 6 x 9 inches, 308 pages. Price $4.00. Contains over 1400 entries on the subject, up to, and including part of, 1933. H. W. Gillett (3b)—B—

Improvements in the Vacuum Fusion Method for Determination of Gases in Metals. Lewis Reeve. *Transactions American Institute of Mining & Metallurgical Engineers,* Vol. 113, 1934, pages 82-110. Includes discussion. See *Metals & Alloys,* Vol. 5, Feb. 1934, page MA 70. (3b)

Slags as Nitrogen Carriers (Schlacken als Stickstoffträger). W. Eilender & O. Meyer. *Stahl und Eisen,* Vol. 55, May 2, 1935, pages 491-493. Although in general the amount of N in the pig iron or steel was greater the more N there was in the slag, no definite equilibrium relationship between the two was found. Pig iron slags contained much more N than basic Bessemer steel slags, the former ranging from 0.001 to as much as 0.1% in N content, whereas basic Bessemer slags contained only from 0.001 to 0.004% N. Basic open hearth steel slags contained from 0.0001 to 0.003% N. SE (3b)

Properties of High Speed Steel Made in the High Frequency Induction Furnace and in the Electric Arc Furnace (Eigenschaften von Schnelldrehstahl aus dem kernlosen Induktionofen und aus dem Lichtbogenofen). R. Scherer. *Stahl und Eisen,* Vol. 55, Mar. 7, 1935, pages 276-279. Service tests were made of several hundred melts of high speed steel made in acid 1-ton and 4-ton high frequency induction furnaces. The general compositions of the steels were 18W, 4Cr, 1.5V; 23W, 4Cr, 1.5V; and 13W, 4Cr, 2.5V. The results were compared with those on electric arc furnace steel of similar composition. Both types of steel gave about the same output in turning; they also showed about the same amount of carbide segregation. The induction furnace steel showed better fractures, however, and fewer defects in stepdown tests. The steels from the 1-ton and 4-ton furnaces were virtually the same. The use of a special melting procedure, with glassy slags, resulted in a higher output in turning. SE (3b)

The Effect of Deoxidation on the Rate of Ferrite Formation in Plain Carbon Steels. C. H. Herty, Jr., M. W. Lightner & D. L. McBride. *Carnegie Institute of Technology & Mining & Metallurgical Advisory Boards, Cooperative Bulletin* No. 64, 1934, 40 pages. See extended abstract, *Metals & Alloys,* Vol. 6, Mar. 1935, pages 71-77. AHE (3b)

The Effect of Deoxidation on the Aging of Mild Steels. C. H. Herty, Jr. & B. N. Daniloff. *Carnegie Institute of Technology & Mining & Metallurgical Advisory Boards, Coöperative Bulletin* No. 66, 1934, 52 pages. See extended abstract, *Metals & Alloys,* Vol. 6, Mar. 1935, pages 71-77. AHE (3b)

The Physical Chemistry of Steel-Making. The Control of Iron Oxide in the Basic Open-Hearth Process. C. H. Herty, Jr., C. F. Christopher, H. Freeman & J. F. Sanderson. *Carnegie Institute of Technology & Mining & Metallurgical Advisory Boards, Coöperative Bulletin* No. 68, 1934, 114 pages. See extended abstract, *Metals & Alloys,* Vol. 6, Mar. 1935, pages 71-77. AHE (3b)

The Deoxidation of Steel. C. H. Herty, Jr. *Carnegie Institute of Technology & Mining & Metallurgical Advisory Boards, Coöperative Bulletin* No. 69, 1934, 68 pages. See extended abstract, *Metals & Alloys,* Vol. 6, Mar. 1935, pages 71-77. AHE (3b)

Economic Considerations on the Obsolete Cupola Furnace Operation (Volkswirtschaftliche Betrachtungen zum veralteten Kupolofenbetrieb). A. Löbner. *Giesserei,* Vol. 22, Mar. 15, 1935, pages 129-133. Considering modern melting practice which is required to produce highly superheated iron, most cupola furnaces work with entirely obsolete methods and waste fuel. Examples are given to show how even such plants can often be remodeled at a moderate cost to work satisfactorily according to present requirements. Ha (3b)

Infiltrated Air in the Open-Hearth Furnace, Its Determination and Avoidance (Falschluft im Oberofen des Siemens-Martin-Ofens, ihre Auswirkung und Vermeidung). G. Köhler. *Stahl und Eisen,* Vol. 55, Apr. 4, 1935, pages 383-391. A method of determining the amount of infiltrated air in the open-hearth furnace is described. The changes in the amount of infiltrated air during the furnace campaign are discussed. This rises sharply at first, then remains constant for a long period, and finally falls off toward the end of the campaign as the pressure in the regenerators increases. The loss in thermal efficiency at the end of the furnace campaign is, therefore, not due to an increase in the amount of infiltrated air. By proper draft and gas-air mixing the amount of infiltrated air can be reduced but not entirely eliminated. This can only be done by proper design of the regenerators, for which recommendations are given. An increase in thermal efficiency of 14% was obtained by obviating the infiltration of air. SE (3b)

Iron Oxide Control in Slag Affords Uniform Product. C. D. King. *Steel,* Vol. 96, Mar. 25, 1935, pages 43-44. Discussion presented at a session of the 8th open meeting of the Metallurgical Advisory Board to Carnegie Institute of Technology. Work of C. H. Herty, Jr., on FeO control is based on practice of open-hearth plants employing no run-off slags. Full application of FeO control is far more difficult in plants operating with such slags. Such plants can only approximate character of melting slag desired and must depend upon adjustment of this slag during refining stages of heat. Since FeO adjustments can be made only within reasonable limits, success of this practice at such plants will depend almost entirely on regularity in composition of pig-Fe, all other conditions being equal. Greatest benefit to be derived from this type of control is increased ability to maintain a greater degree of uniformity of product and increased metallurgical knowledge resulting. Emphasizes some of the features indicated by Herty. MS (3b)

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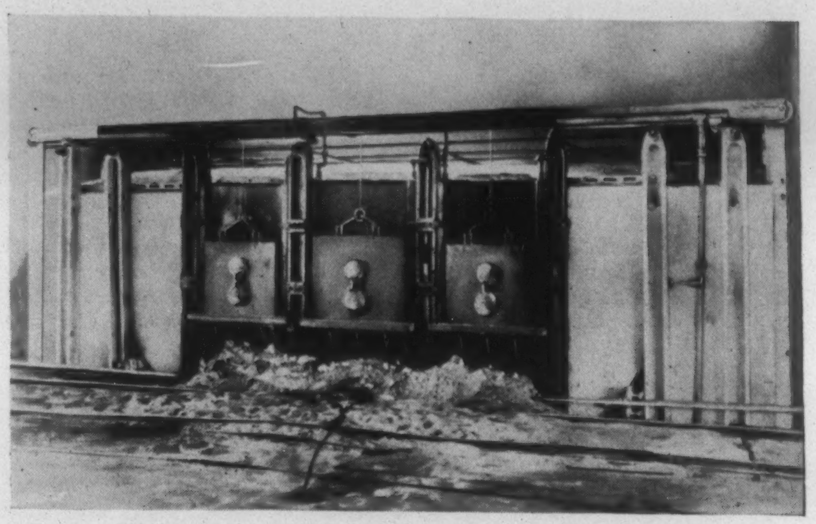

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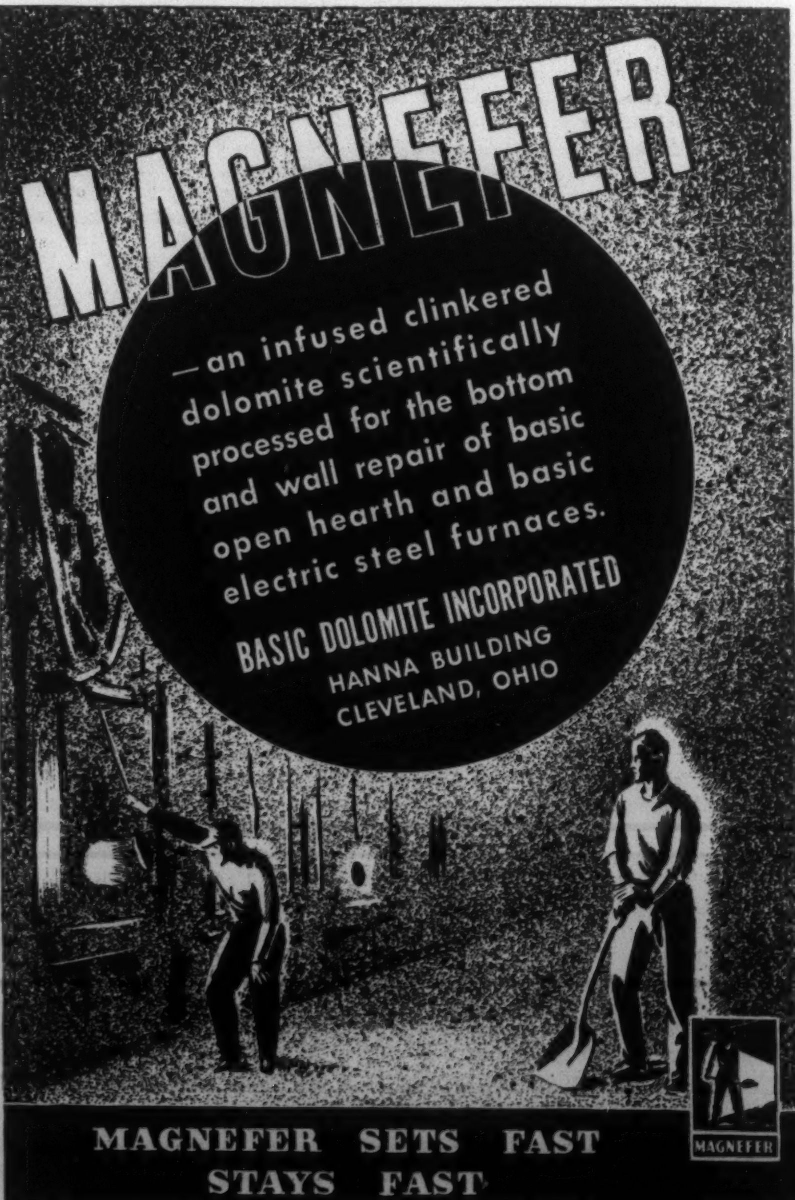
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4. WORKING

Forming and Finishing Aluminum (Die Bearbeitung des Aluminiums). E. Herrmann & E. Zurbrügg. Akademische Verlagsgesellschaft, Leipzig, 1935. Paper, 5 x 8½ inches, 106 pages. Price 4 RM.

The authors, in about 100 pages, have given a very comprehensive summary of methods of forming and finishing aluminum. These include various methods of forming, such as bending, drawing, stamping, etc.; working with cutting tools, joining by riveting, welding, soldering, etc.; finishing by mechanical methods, such as polishing, or by chemical treatments, such as etching. A short chapter is devoted to coating by chemical and electrochemical oxidation, and by electroplating, painting, lacquering, etc. The methods generally appear to be carefully selected on the basis of practical experience, but the book is necessarily limited in detail. For American readers, this book is of limited practical use because the alloys and many materials are referred to by their German trade-names without reference to composition. Junius D. Edwards (4)—B—

Extrusion and Finishing of Collapsible Tubes. Henry Frank. *American Machinist,* Vol. 79, Feb. 27, 1935, pages 193-196. Handling of the molten Sn or Pb and process of extruding and finishing is described in detail. Ha (4)

4a. Rolling

RICHARD RIMBACH, SECTION EDITOR

Cast Steel Rolls. Their Manufacture, Their Defects (Les cylindres de laminoirs en acier coulé—leur fabrication—leur défauts). L. Quincy. *Revue de Métallurgie,* Vol. 32, Jan. 1935, pages 1-22; Feb. 1935, pages 69-84. Casting defects proper consist of blow holes and sand or slag inclusions. They can be eliminated by proper attention to founding practice. Phenomena causing shrinkage are discussed. Sound rolls cannot be produced without sink heads. A series of 15 cases is given in which the shape of the sink heads is investigated and the ratio of its volume to the body of the roll is studied by changing it from 0 to 85%. The yield of sound metal recorded varied from 36 to 93%, but no definite relation between the ratio and the yield could be found. Photographs of the longitudinal sections of the rolls made are given. Cold top pouring does not prevent piping. Placing a solid chill inside of the mold usually caused a circular shrinkage cavity near the top of the roll. A core within a mold caused practically the same trouble. The best results are obtained when a properly designed sink head is used together with pumping. Electrical heating of the sink head can replace the latter. It is not a universal cure, however. Liquation causes segregations increasing the non metallic content towards the center. No remedies for its elimination are offered. From the mechanical standpoint this defect presents but little danger. Dark lines corresponding to segregations in dendritic areas can be often seen on the outside of rolls 40 cm. or more in diameter and in the whole body of smaller diameter rolls. The internal zone of larger rolls does not contain them. They can be reduced by care in adding additions and deoxidizing. A number of rolls which were broken prematurely always showed the same structure—a coarse grained core, an intermediate zone containing tears and the sound outside layer. Premature breaking is caused by the phenomenon of solidification producing areas of weakness reaching across the body of rolls from one side of the outside shell to the other. The areas of weakness are bound by a lenticular body the edges of which touch the outside skin and the thickness of which was recorded as 4 mm. It corresponds to the areas at which the freezing occurred last. On cutting through the outside skin on the lathe the cracks are exposed and the roll is liable to fall apart. No effective means for elimination of these internal cracks are known at present. JDG (4a)

General Utility Mill for Output of 180 Tons Per Hour (Einstich—Duo—Sonderstrasse für 180 t Stundenleistung). *Stahl und Eisen,* Vol. 55, Mar. 28, 1935, pages 353-356. The layout and operation of a continuous two-high merchant and structural mill is described. SE (4a)

New Rod and Wire Mill (Neues Feineisen und Drahtwalzwerk). *Stahl und Eisen,* Vol. 55, Feb. 21, 1935, pages 206-211. The layout of the mill is shown and innovations such as individually driven rollers, and automatic cooling beds discussed. SE (4a)

Development of the Tata Sheet Mill. *Blast Furnace & Steel Plant,* Vol. 23, Mar. 1935, pages 196, 214. Description of equipment installed at various times in the sheet mill of the Tata Iron & Steel Company, India, and of the results obtained. MS (4a)

Results of Tests of Measuring Instruments for the Study of the Rolling Process (Ueber Erfahrungen mit Messgeräten, besonders dynamischen Dehnungsmessern, zur Untersuchung des Walzvorganges). H. Hoff & T. Dahl. *Stahl und Eisen,* Vol. 55, May 2, 1935, pages 485-491. The advantages of a new instrument for measuring the speed of rolling are given, and an apparatus for measuring the power used in rolling described in detail. SE (4a)

New Device Indicates and Records Rolling Loads. *Steel,* Vol. 96, Apr. 22, 1935, pages 43, 45, 52. Pressure block, consisting of top and bottom housings inclosing a steel cylinder with cut metal rings and electrical apparatus attached is placed between bearing chuck and screw-down of rolling-mill. Loads increase circumference of cylinder, causing ends of rings to separate. These movements are translated into electrical quantities which, due to previous calibration, are measurable directly in lbs. load. By the use of this apparatus, maintenance expense has been reduced; insurance against overload has been provided; and rolling schedules have been adjusted from the pressure point of view with the result that lower pressures are used, faster rolling speeds are maintained, tonnage is increased, and cost per ton decreased. MS (4a)

Hot Strip Steel Is Coiled During Cycle of Rolling. John D. Knox. *Steel,* Vol. 96, Feb. 4, 1935, pages 58, 61-62. McLouth Steel Corp., Detroit, has put into operation a new type of 2-high 21½″ x 20″ reversing mill, the first to be operated in the U. S. on a commercial basis. Chief innovation is that it is served by 2 fuel-fired heating furnaces, 1 spanning the front mill table, and 1 the back mill table, each spaced about 18¾ ft. from the center-line of the rolls. A power-driven reel operates within each furnace and winds the strip into a coil during reduction. At the outset mill is operated as a conventional slabbing mill. Heated slab is delivered onto mill approach table by a set of pinch rolls which is an integral part of the roller table. About 75 ft. from the heating furnace slab enters a 16½″ vertical edging mill, from which it progresses about 16 ft. into a stand of 12″ duplex type pinch rolls. A similar stand of pinch rolls is on the opposite side of the mill. About 12 ft. from the pinch rolls slab enters the 2-high reversing mill. When slab has been rolled down to a thickness suitable for coiling, the strip is delivered into the heating furnaces and rolling continued until the desired thickness is obtained. It is then conveyed to a 3-roll coiler. MS (4a)

Rolling Mill Practice. W. H. Melaney. *Blast Furnace & Steel Plant,* Vol. 23, Apr. 1935, page 271. In rolling of sheets and strip, the smaller the diam. of rolls, the less will be the spread in proportion to the elongation. Tension on sheet and lubrication during rolling also reduce spread, resulting in less difference in thickness between center and edges of sheet. Reason for this is that there is less piling up of the rolled material and therefore less elastic come-back after rolling pressure has been relieved. MS (4a)

Rolling Long Thin Sheets (L'évolution des Procédés de Laminage de la Tôle Fine en Longues Bandes). V. Sallard. *La Technique Moderne,* Vol. 27, Apr. 1, 1935, pages 221-227. In Steckel process, which can be applied to both cold and hot rolling, rolling is done alternately in opposite directions in a single 4 roll housing. In the cold process the sheet is wound up on drums on each side of the rolls. It is thus possible to have the working rolls of very small diameter and consequently a higher reduction for each pass with a less cold hardening which makes unnecessary intermediate annealings. This process gives sheet of higher finish having a better drawing capacity after the final annealing. When sheets are to be tinned, the high polish lessens the Sn consumption. In the hot process, a furnace is placed on each side of the roll housing and the sheets are wound up on drums inside of the furnaces. The Steckel process is said to be a noticeable advance for European conditions with which it was hardly possible to economically operate continuous mills with numerous roll housings involving a high investment. New rolling plants using both cold and hot processes are described and illustrated. FR (4a)

Special Induction Motors Are Employed to Drive Hot Strip Mill Coilers. T. R. Rhea. *Steel,* Vol. 96, Feb. 4, 1935, page 56. Brief description of construction and control. MS (4a)

Artificial Plastics for the Manufacture of Friction Bearings (Aufbau der Kunstharz—Pressstoffe für die Anfertigung von Gleitlagern). W. Stodt. *Stahl und Eisen,* Vol. 55, Feb. 14, 1935, pages 183-185. The preparation of the materials used as fillers such as cotton shreds and paper are described. The coefficient of friction; the bending, impact and compressive strength; Brinell hardness; density; heat resistance; coefficient of expansion; and heat conductivity of several such plastics are tabulated. These plastics have been installed in various types of bearings in rolling mills with good results. SE (4a)

The Use of Roll-Collars and Roll-Collar Rolls. (Die Verwendung von Walzringen und Walzringwalzen). H. Cramer. *Stahl und Eisen,* Vol. 55, Feb. 28, 1935, pages 235-239. Various economical methods of turning for cutting enclosed profiles, and for working with roll-collar rolls without special attachments are described. SE (4a)

Thermostat Protects Table Motors Against Overload. G. A. Caldwell. *Steel,* Vol. 96, Apr. 8, 1935, pages 42, 45. To protect sheet roller and catcher table motors against overload, a bimetal disk is mounted on the end turns of the winding. Its contacts snap open at a given temperature and either disconnect motor from line by dropping out a contactor or give advance warning that an abnormal condition exists. MS (4a)

Cold Straightening of Rails and Shapes (Das Kaltrichten von Schienen und Profileisen). A. Flügge. *Stahl und Eisen,* Vol. 55, Feb. 14, 1935, pages 177-182. Different methods for straightening rails and shapes in Germany and elsewhere are discussed. New types of straightening rolls are described. SE (4a)

Further Improvements in Seamless Tube Manufacture. Gilbert Evans. *Metal Industry,* London, Vol. 45, Oct. 12, 1934, pages 339-341. The author describes briefly the salient points of the combination of rotary piercing and rolling mills used in the manufacture of seamless tubes under the Foren patents. The whole operation is completed from one heating of the original round billet. The advantages of this process are indicated. HBG (4a)

New Broad Strip Mill of Sheet and Tube Starts Production in Record Time. John D. Knox. *Steel,* Vol. 96, Apr. 29, 1935, pages 42-43, 56. Describes continuous sheet mill and accessory equipment at the Campbell plant of the Youngstown Sheet & Tube Co. Mill is built with roughing train and finishing train of rolls in tandem. Former includes a 2-high 24″ x 79″ scale breaker, a 4-high 24″ and 49″ x 96″ spreader, a squeezer, and 3 4-high universal mills with vertical rolls on approach side and with work rolls 24″ x 79″ and back-up rolls 49″ x 79″. Latter comprises a 2-high 24″ x 79″ scale breaker and 6 stands of 4-high rolls, 24″ and 49″ x 79″. MS (4a)

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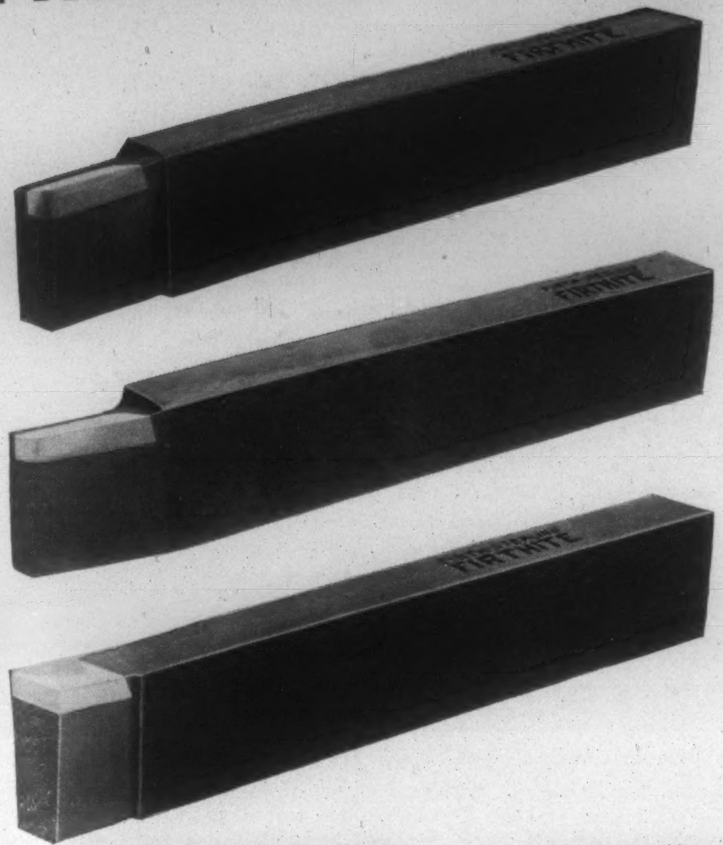

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4b. Forging & Extruding

A. W. DEMMLER, SECTION EDITOR

7000-Ton Electro-Hydraulic Forging Press Plant. *Mechanical World & Engineering Record*, Vol. 97, Feb. 22, 1935, pages 182-184. **Electro-Hydraulic Forging Plant.** *Heat Treating & Forging*, Vol. 21, Mar. 1935, pages 125-128. Description of a plant capable of handling ingots up to 250 tons in weight. See "The Heavy Forge Department of the English Steel Corporation, Ltd.," *Metals & Alloys*, Vol. 6, May 1935, page MA 182. Kz + MS (4b)

4c. Cold Working, including Shearing, Punching, Drawing & Stamping

Mechanical Skill Paramount in Production of Small Springs. L. E. BROWNE. *Steel*, Vol. 96, Apr. 15, 1935, pages 42-43. Describes operations in making feather-weight open-wound helical springs at the Worcester, Mass., plant of the American Steel & Wire Co. 56,000 of the heaviest of these weigh 1 lb. Hot-rolled music wire rod, about ¼″ diam., is patented, cleaned, and drawn through alloy steel dies with repetition of heat treatments and cleaning operations at required intervals, until wire is about 0.030″ diam. It is then coated with a soft special alloy and drawn further. Final step consists of 16 consecutive drafts through diamond dies. About 40 drafts and 4 or 5 heat treatments are required to convert rod to finished size of 0.005″ diam. Wire is coiled on a small specially designed machine, producing about 50 springs a minute. MS (4c)

Alloy Steel Wire. RICHARD SAXTON. *Iron & Steel Industry*, Vol. 8, Oct. 1934, pages 5-6. The manufacture of alloy steel wire follows in general the practice of carbon steel wire. Heat treatment due to greater density of metal must be a slower operation; temperature of furnace while charging should never be above 400° C. Furnace control by means of pyrometers is essential. Drawing of alloy steels is a difficult operation as the metals when subjected to pressure respond to plastic deformation less effectively than carbon steels. CMS (4c)

Lubricants in Modern Drawing of Steel Wire (Les Lubrifiants dans le Trefilage moderne de l'Acier). M. MICHEL. *Usine*, Vol. 44, Feb. 14, 1935, page 31. Necessity for good lubrication is pointed out, properties and methods of using lubricants are discussed briefly. Ha (4c)

How to Prevent Breakages in Drawn Shells. C. W. HINMAN. *Sheet Metal Industries*, Vol. 9, Jan. 1935, pages 27-28. From *Canadian Machinery*. Effects of drawing radii, time factor on the draw, diameter of the shell for redraw, and lubricants are treated. AWM (4c)

Eliminating Fluting in Annealed Sheet Steel. WAYNE A. SISSON & GEORGE L. CLARK. *Sheet Metal Industries*, Vol. 9, Jan. 1935, pages 15-16. See "Fluting in Annealed Sheet Steel and Its Elimination," *Metals & Alloys*, Vol. 5, May 1934, page 103. AWM (4c)

Testing the Drawing Properties of Rolled Zinc Alloys. E. H. KELTON & GERALD EDMUNDS. *Transactions American Institute Mining & Metallurgical Engineers*, Vol. 111, 1934, pages 245-253. Includes discussion. See *Metals & Alloys*, Vol. 5, June 1934, page MA 254. (4c)

Relation between Plastic Deformation in Deep Drawing and Tensile Properties of Various Metals. M. H. SOMMER. *Transactions American Institute of Mining & Metallurgical Engineers*, Vol. 113, 1934, pages 273-291. See *Metals & Alloys*, Vol. 5, June 1934, page MA 254. (4c)

4d. Machining

H. W. GRAHAM, SECTION EDITOR

High Speed Machining of Iron Castings. L. M. ANGUS-BUTTERWORTH. *Mechanical World & Engineering Record*, Vol. 97, Apr. 5, 1935, pages 323-324. The influence of the composition of cast iron on machinability is discussed. Dealing with the problem of how to obtain maximum machinability in castings, 2 methods are discussed, (a) to regulate the composition, (b) to secure the desired qualities by heat treatment. Careful metallurgical control, together with the subsequent heat treatment, can largely eliminate the need for expensive alloys such as Ni and Cr in the Fe, and strength and wearing qualities can be maintained in castings of ordinary composition. Kz (4d)

Modern Super-Hard Cutting Materials. H. BEENY. *Iron & Coal Trades Review*, Vol. 130, Mar. 22, 1935, page 487. Manufacture and uses of recently developed cutting materials with hardnesses much greater than those of high-speed steels or stellite are described. They are made up of infused hard carbide grains of W, Ta, V, Ti and Mo with the addition of 3-13% Co which acts as binder in the sintering process at 1500° C. at which it melts. The diamond pyramid hardness number varied from 1100 to 1550 while high speed steel has only 851. Factors to be considered in machining and influences affecting tools are discussed. Ha (4d)

Modern Methods of Machining Non Ferrous Metals and Alloys (Les Méthodes Modernes d'Usinage des Métaux et Alliages Non Ferreux). ERNST PREGER. *La Technique Moderne*, Vol. 27, Mar. 1, 1935, pages 159-160. Description of new machine tools shown at the recent Leipzig Fair. FR (4d)

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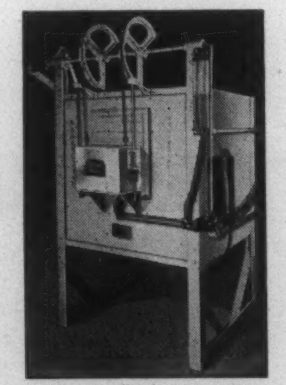

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5. HEAT TREATMENT

O. E. HARDER, SECTION EDITOR

Heat Treatment of Cast Iron Which Does Not Contain Any Alloy (Traitements thermiques des Fontes qui ne contiennent aucun alliage). T. Boissaux. *Revue Technique Luxembourgeoise,* Vol. 27, Jan.-Feb. 1935, pages 1-6. The different processes to improve the properties of cast irons by heat treatment according to their various purposes are reviewed. Pieces which tend to warp or fracture should be subjected to a simple annealing to remove internal stresses or to soften eventual hard spots. Ordinary castings should not be subjected to hardening treatment. 22 references. Ha (5)

Fundamentals of Commercial Heat Treatment. Albert J. Dornblatt. *Heat Treating & Forging,* Vol. 20, Dec. 1934, pages 593-596; Vol. 21, Jan. 1935, pages 15-18. Elementary discussion of the properties of steel that are affected by heat treatment and of the nature, purpose, and effects of the different commercial heat treating processes. MS (5)

Grain Size Effect in Heat Treatment Better Understood. *Steel,* Vol. 96, Jan. 7, 1935, pages 150, 267-268. Reviews 1934 developments in heat treating and metallurgy as related to heat treating. MS (5)

5a. Annealing

Accurate Annealing. E. F. Lake. *Heat Treating & Forging,* Vol. 21, Apr. 1935, pages 177-178. Formulates rules that should be followed to obtain best results in annealing. Steel should be heated to but a few degrees above its highest transformation point for a time long enough to allow change in grain structure to be completed in all parts, and then cooled very slowly. MS (5a)

Annealing of Pure Aluminum (Sur le Recruit de l'Aluminium Pur). Jean-J. Trillat & M. Paic. *Comptes Rendus,* Vol. 200, Mar. 18, 1935, pages 1037-1039. X-ray examination of fibred structure of high purity Al and Al of commercial grade confirms the work of Calvet (*Comptes Rendus,* Vol. 200, Jan. 2, 1935, pages 66-68) on variations of time and temperature of annealing.

Refined 99.993%—Recrystallization begins at 170-180° C. after 10 minutes.
Complete recrystallization occurs at 230-250° C.

Commercial Al with 0.7% Fe, 0.3% Si }
" " " 0.3% Fe, 0.7% Si } Recrystallization begins at 200-220° C. after 10 minutes and is complete at 280-300° C.

FHC (5a)

5b. Hardening, Quenching & Drawing

Roll Neck Bearings Are Rejuvenated in Special Oil Bath Furnace. *Steel,* Vol. 96, Feb. 11, 1935, page 53. Timken Röller Bearing Co. recommends that in relieving large roll neck bearings of hardening strains, maximum drawing temperature should be 350° F. and minimum temperature, 325° F. Minimum time at temperature should be 2 hrs./in. of maximum cross-section of any component part of a bearing. It is advisable to draw bearings about every 3-6 months. Oil used in furnace should be neutral paraffin, 28°-29° Bé; viscosity, 100 sec. at 100° F.; flash-point, 375° F.; fire-point, 425° F. 15-day test drawing 153 tons of bearings in a furnace, 66″ diam. with an effective loading depth of 37″ showed an average consumption of 55 kw.-hr./ton of bearings drawn. Bearings can be drawn as complete assemblies. MS (5b)

Notes on Cobalt Magnet Steels. L. Sanderson. *Machinery,* London, Vol. 45, Mar. 21, 1935, page 809. Suggested heat treatment for 9-16% Co steel is; heat quickly to 1200° C. and air cool, which makes steel non-magnetic. Next, reheat to 700-750° C. and air cool. If steel is charged with furnace at 650° C. then brought up to 750° C., material will show a distinct glow which is characteristic of Co steel properly treated in the previous 2 steps. The material is now magnetic. The final step is to heat rapidly to 1000° C., air cool until magnetic then cool in thin, cool oil. The 35% Co steel is charged to a furnace maintained at 950° C. with door open and the material watched as the temperature rises. When up to furnace temperature it has a clear red color and should be quenched in cool, thin oil. When properly hardened it has residual magnetism of 9000 lines/cm.^{2} and coercive force, of not less than 240. For full magnetic value right to center of bar the diameter of the 9-16% Co steels in 4½″ section should not be more than ¾″ to ⅞″. In the 35% Co steels the full magnetic hardness is obtained only for material 9 mm. or less from the surface in rounds and 7 mm. or less for flats. The 35% Co steel must be machined with care due to tendency to brittleness and spalling. WB (5b)

Better Machine Bits. James Hyslop. *Yearbook on Coal Mine Mechanization,* 1933, Coal Division, American Mining Congress, pages 75-80. See *Metals & Alloys,* Vol. 4, Nov. 1933, page MA 353. AHE (5b)

Patenting Temperatures. K. B. Lewis. *Wire & Wire Products,* Vol. 10, Mar. 1935, pages 104-105, 117-118. Patenting of steel wire is a sorbitizing process employed to obtain good ductility in the material. The improvement is generally ascribed to the development of a large grain. The various opinions on the subject (Foley, Clayton, Rummer and others) are discussed. A temperature of 500° C. for sorbitizing gives best results. Ha (5b)

Embrittlement of Low-Carbon Steel. F. C. LEA & R. N. ARNOLD. *Institution of Mechanical Engineers, Proceedings,* Vol. 127, Apr.-Nov. 1934, pages 299-332. Includes discussion. See *Metals & Alloys,* Vol. 6, Mar. 1935, page MA 100. Ha (5b)

5c. Aging

Changes in the Properties of Steel Wire Through Aging at Room Temperature and in the Cold (Die Aenderung der Eigenschaften von Stahldraht durch Lagern bei Raumtemperatur und in der Kälte). N. PÜNGEL, K. LIEBERKNECHT & E. H. SCHULZ. *Archiv für das Eisenhuttenwesen,* Vol. 8, Feb. 1935, pages 365-369. Studies of cold drawn wires (0.48 to 0.84% C) showed in general an increase in tensile strength and a loss in elongation and reduction of area on aging at room temperature up to 259 days. Type of material and composition had little influence on the results. The relative effect was greater for the lower degrees of deformation. Double patented wire showed a greater reduction in ductility than single patented. Tempering at 250° C. 1 hr. caused a greater reduction than room temperature aging for low and medium degrees of cold working; with more severe working there was little difference between aging at room temperature and 250° C. tempering. With lowered testing temperature (0 to —20° C.) the tensile strength and elongation of cold drawn wire was increased; the reduction of area remained unchanged. The effect on no. of bends and twists was small. The type of working and treatment appeared to have no effect on the behavior at low temperatures. Tests of the solubility of the wire in HCl showed a large effect of cold working and aging; up to 90% cold work the solubility increased, then decreased; tempering seemed to lower the solubility. SE (5c)

5e. Carburizing

A New Heat Treatment for Ferrous Metals. CECIL J. ALLEN. *Railway Engineer,* Vol. 56, Jan. 1935, pages 413-414. Calls attention to the "Penetral process" with its 3 variations designed to give resistance to oxidation, abrasion and corrosion. It can be applied to malleable Fe, some grades of cast Fe, rolled, forged and cast steel, and most of the ferrous alloys with no free C. No important details are given on this case hardening process which is claimed to appear likely to displace the ordinary carburizing and nitriding case hardening processes. Service condition results gained on tubular heaters, recuperator tubes, case-hardening pots are mentioned. The process is said to have been recently applied to the treatment of brake drums, track links, gun barrels, valves for aviation engines, crank shafts and pump linings. WH (5e)

Liquid Carburizing Medium Produces Deep, Uniform Case. *Steel,* Vol. 96, Mar. 18, 1935, page 56. See *Metals & Alloys,* Vol. 5, Sept. 1934, page MA 167. MS (5e)

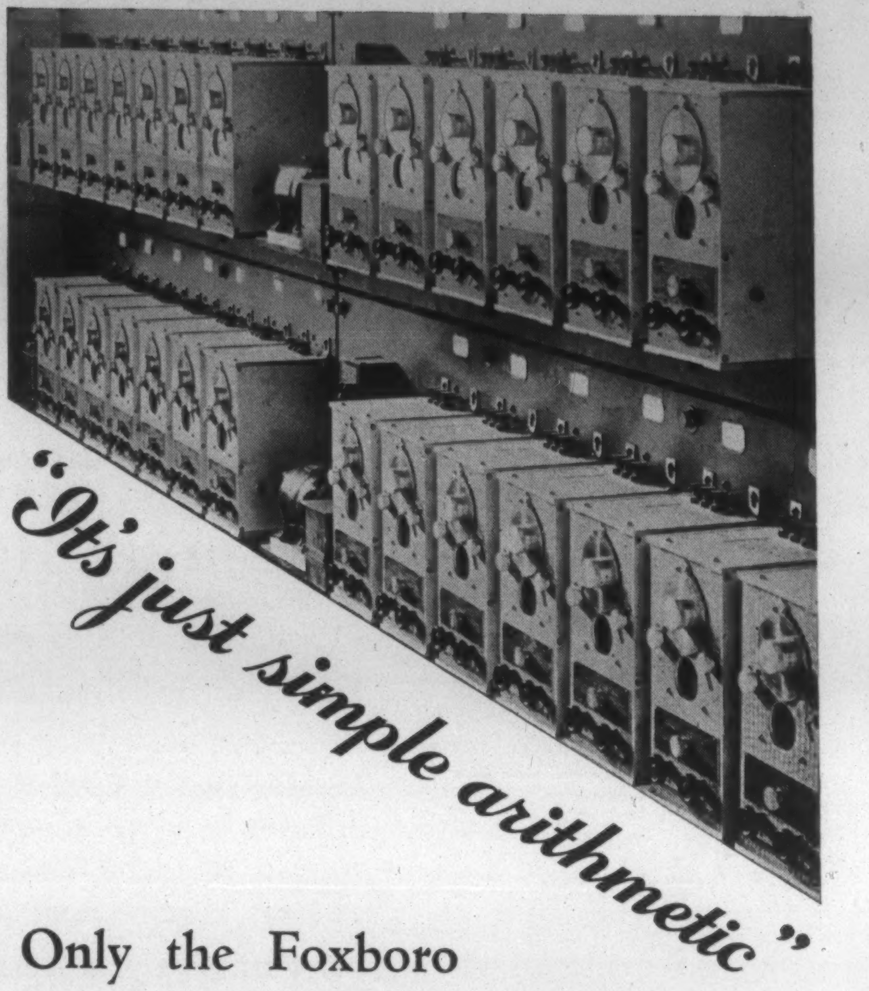
Case Hardening and the Use of Nickel Steels. *Machinery,* London, Vol. 46, Apr. 18, 1935, pages 73-76. A survey of the carburizing operation, effect of Ni on heat treatment in allowing oil quenching and eliminating one heat treatment entirely, that from 900° C. A series of tests carried out by Mond Nickel Co., Ltd., shows in tabular form the mechanical properties of 3% Ni steel after single and double heat treatment and fracture photos are shown for carburized and oil quenched from 760° C. steel with range from 0 to 5% Ni and practically constant C from .15-.12%. General properties of 3 and 5% Ni steels are discussed. Brief review of Ni-Cr, Ni-Mo and Ni-Cr-Mo steels. WB (5e)

A B C of Methods Employed in Carburizing Steel. JOHN F. WYZALEK. *Steel,* Vol. 96, Feb. 4, 1935, pages 34-35. See "Carburizing Practice," *Metals & Alloys,* Vol. 6, Apr. 1935, page MA 144. MS (5e)

5f. Nitriding

Nitrogen Hardened Cast Iron (Stickstoffgehärtetes Gusseisen). A. N. DOBROWIDOW & N. SCHUBIN. *Archiv für das Eisenhuttenwesen,* Vol. 8, Feb. 1935, pages 361-363. To get a uniform nitrided layer, it was found necessary to use cast-iron without large graphite flakes; a desirable structure was obtained by annealing white cast-iron. The content of alloy elements necessary for nitride hardening, Al and Cr, had to be so chosen that the white iron could be graphitized fairly readily. After graphitization it was desirable to eliminate free ferrite by a quenching treatment. A cast-iron with about 2.75% C, 0.25% Si, 0.8% Al, 1% Cr, could be graphitized on annealing about 8 hrs. at 1000° C, after which the formation of free ferrite was avoided by quenching from 900° C. into oil to give a troostitic structure. On nitriding such cast-iron for 40 hrs. at 500° C a uniform nitrided layer with a Herbert pendulum hardness of from 75 to 80 was obtained. The toughness of the layer was improved by a small Ni addition. SE (5f)

Centrifugally-Cast Nitrided Iron Tubes Resist Wear. ERLE F. ROSS. *Steel,* Vol. 96, Feb. 11, 1935, pages 40-42. **Nitriding Iron Cast Centrifugally.** *Foundry,* Vol. 63, Mar. 1935, pages 26-27, 62. Describes practice of Forging & Casting Corp., Ferndale, Mich., for producing cylinder liners of "Nitricastiron." Composition is 2.50-2.70% C, 1.20-1.50% Cr, 0.50-0.60% Mn, 2.40-2.60% Si, 0.8-1.10% Al, and 0.20-0.25% Mo Metal is prepared from pig-Fe and high-C steel scrap in a 250-lb. electric furnace. Al is added to ladle with cryolite. Tubes are cast in a horizontal machine rotating at 600-1400 r.p.m. Wall thickness is controlled by amount of Fe poured into mold. Tubes are heated to 1750° F. for 1 hr., air cooled, reheated to 1475° F. for 1 hr., and air cooled. They are rough machined and stress relieved at 1150° F. for several hrs. To protect outer surfaces during nitriding, tubes are Ni plated and inside diam. ground to size. or outer surfaces are painted with a Pb-Sn-oil mixture. Nitriding is done at 960° F. for 50-60 hrs. VSP + MS (5f)



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6. FURNACES, REFRACTORIES AND FUELS

M. H. MAWHINNEY, SECTION EDITOR

Experiences with the New Refractory Brick for the Open-Hearth (Erfahrungen mit neuartigen hochfeuerfesten Steinen für Siemens-Martin-Oefen). A. Heger, A. Sonntag & M. Leineweber. *Stahl und Eisen,* Vol. 55, Mar. 7, 1935, pages 265-276. Trials with new refractory brick given by trade name as Emgeo, Magnesidon, Radex A, Radex E, Chromodur, Chromore, Rubinite, and Siemensite, were made in different locations in the open-hearth. The special brick gave considerably longer life than silica brick, so that by their use the output of the open-hearth may be raised as much as 20%. SE (6)

Experiences with Special Bricks in the Open-Hearth (Erfahrungen mit Sondersteinen an Siemens-Martin-Oefen). F. W. Morawa. *Stahl und Eisen,* Vol. 55, Feb. 21, 1935, pages 201-206. Results with the use of special refractory magnesite and chromite brick in the open-hearth are compared with those with silica brick, and shown in a table. SE (6)

Installs New Equipment for Heat Treating Springs. *Steel,* Vol. 96, Apr. 22, 1935, pages 36-37. For heating treating springs and small stampings, Duer Spring & Mfg. Co.. McKees Rocks, Pa., has installed a continuous hardening furnace, floor-level oil-quench tank, and rotary retort batch-type drawing furnace. Both furnaces are fired by natural-gas. MS (6)

Atmospheres Controlled in New Furnaces at Auto Plant. A. H. Allen. *Steel,* Vol. 96, Apr. 15, 1935, pages 38-39, 41. Packard Motor Car Co., Detroit, has installed 2 new furnace units. Cam-shafts are gas carburized in a batch-type muffle furnace. Carburizing gas is Propane, C_3H_8 which has been cracked with 9 parts air to 1 C_3H_8, washed, and dried. After shafts are charged, cracked gas alone is admitted to muffle for 2½ hrs., then raw C_3H_8 is added in proportion of 2 parts cracked gas to 1 C_3H_8. Temperature is raised to 1775°F. After 13 hrs., charge is placed in cooling chamber, maintained by gas burners at 1000° F. Temperature rises to 1375°F. after 4 hrs. When temperature falls to 1000° F. charge is removed and cooled in air. Shafts are hardened in a deep circular cyanide pot. Axle shafts, of S.A.E. 4140 Cr-Mo steel, are hardened, oil quenched, and drawn continuously in an automatic gas-fired unit which gives a scale-free product. Muffle gas is prepared by cracking, washing, and drying city gas. Hardening temperature is 1540°F. and drawing temperature is 850°F. MS (6)

Fundamentals, Development and Examples of Combustion Calculations (Grundlagen, Entwicklung, und Beispiele feuerungstechnischer Berechnungen). H. Schwiedessen. *Archiv für das Eisenhüttenwesen,* Vol. 8, Feb. 1935, pages 329-336 Specific examples of the use of formulae previously developed for calculating the amount of dry and moist flue gas, air required, and excess air, are given. SE (6)

Further Development of Rim-type Heating Elements (Weitere Entwicklung der Felgenheizelemente). O. Junker. *Elektrowärme,* Vol. 5, Apr. 1935, pages 73-79. The previously described heating elements of Ni-Cr alloys in shape of a rim are now used up to 850° C. as heating elements and simultaneously as supporting members for roof and other parts of the furnace by giving them suitable shape. Above 850° to 1300° C. they cannot be used as supporting elements as creep strength becomes too low. Examples of large continuous and chamber furnaces are described showing the considerable savings in weight of furnace and current consumption in operation made possible by thin heating elements. Ha (6)

Propane and Butane as Industrial Fuels. E. A. Jamison & W. H. Bateman. *Iron & Steel Engineer,* Vol. 12, Apr. 1935, pages 209-214. These materials possess the transportation and storage advantages of fuel oil and the possibilities of control of gas. 1 ft.^{3} of liquid at 60°F. gives 31.5 to 36.2 ft.^{3} of gas at that temperature. Data are given showing certain economies for cutting torch work over acetylene. WLC (6)

Gaseous Fuels in Modern Open Hearth Furnace Practice. John H. Hruska. *Industrial Heating,* Vol. 2, Feb. 1935, pages 87-90; Mar. 1935, pages 143-144; Apr. 1935, pages 199-200. The various gaseous fuels used in open hearth practice and their influence on the heat balance of the furnace and charge and on the reactions in the furnace are discussed. Use of hot gas is preferable to cold gas. Ha (6)

Time Required for Heating Steel. J. D. Keller. *Heat Treating & Forging,* Vol. 21, Feb. 1935, pages 63-67; Mar. 1935, pages 117-120. Deals with the calculation of the time required to heat square bars to a given temperature in a furnace. If the square bar is freely exposed to radiation from all sides, the time required for heating it is slightly longer than for a round bar with diam. equal to the thickness of the square, and just half as long as for a plate of the same thickness. Considers also distribution of temperature at center, corners, and middle of sides. MS (6)

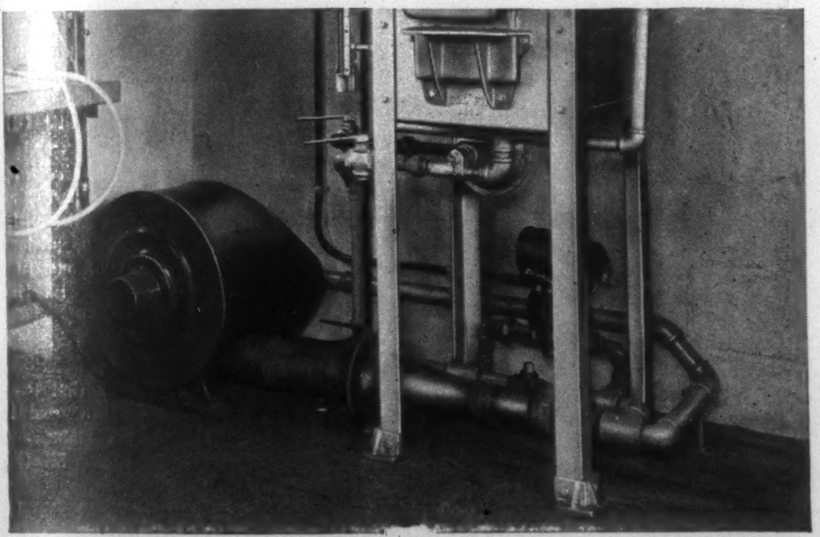
Most Recent Electric Melting Furnace for Light Metals (Der neuste elektrische Schmelzofen für Leichtmetalle). E. Fr. Russ. *Aluminium,* Vol. 17, Mar. 1935, pages 136-141. A new type of induction furnace is described where around the primary coil a circular vertical trough is provided which is always filled with Al and acts in cold state as secondary; this trough connects on top with the chamber into which the charge (scrap, new material) is filled. The furnace is emptied by tilting. The melting capacity of such a furnace of 4-5 tons is said to be 3 to 5 times higher than a hearth furnace of equal capacity and saves 30-50% energy consumption. Castings of very good quality have been obtained from metal melted in this furnace. Ha (6)

Trends of Research in Refractories Used in Steel Plants. J. H. CHESTERS. *Brick & Clay Record*, Vol. 86, Mar. 1935, pages 96-97. Most of the recent technical developments consist of attempts to reduce the weaknesses of existing materials by suitably varying the batch composition, grading, molding technique, etc. The discovery that de-aired clay has a mechanical strength much greater than the normal material may lead to improvements in the quality of nozzles, runner brick, etc. Work is being pushed to develop a more stable quartz brick. The so-called "black" silica brick, in which iron oxide is used as a mineralizer to produce large amounts of tridymite, has been used in Europe. The use of electrically sintered Grecian magnesite for the production of a high slag resisting and spalling resisting brick has met with considerable success. Work has also been done in the use of un-burned magnesite brick. Considerable improvements in the properties of chrome brick have resulted from physical and chemical correction of chrome ores. Super-refractory crucibles and tubes from beryllia, zirconia, tungsten carbide, etc., have been investigated. CBJ (6)

High-Frequency Induction Furnace Gives Close Control in Melting Special Alloys. EDWIN F. CONE. *Steel*, Vol. 96, Apr. 15, 1935, page 60. Driver-Harris Co., Harrison, N. J., uses two 1000-lb. high-frequency furnaces for melting Ni-Cr alloys. Advantages are close regulation of low percentages of C; remelting of scrap without any substantial change in C content; composition of heat can be duplicated; smaller heats are possible, keeping down inventory; fewer ingot-molds are required; melts can be poured directly into mold; precision alloys containing special rare metals can be produced; and power-factor is high, load is uniform, and there is no penalty for day-time operation. MS (6)

Electric Heating. E. OPENSHAW TAYLOR. *Journal Society of Chemical Industry*, Vol. 53, Nov. 9, 1934, pages 945-948; *Heat Treating & Forging*, Vol. 20, Dec. 1934, pages 597-599. Discussion of the use of electricity for the heat-treatment of metals, melting and refining of metals and the welding of metals. Costs and power consumption are given. VVK+MS (6)

Industrial Electric Heating. E. C. WARD. *Journal & Record of Transactions of the Junior Institution of Engineers*, Vol. 45, Nov. 1934, pages 51-72. Paper before Midland Section, Birmingham, Mar. 1934, covers history of electric heating, arc, induction and resistance heating. Summarizes the statements as follows: the acid-lined arc furnace is used mostly for foundry work, while the basic-lined furnace is used for making high-grade C and alloy steels, where a certain amount of refining is essential. Over 90% of modern equipment (in England) is of the 3-phase direct type. The vertical ring induction furnace is used for the production of wrought brass and silver-nickel, while the coreless induction furnace is used for the melting of high-grade Ni-rich alloys of every description and the complex alloy and tool steels, such as magnet, high-speed, heat resistant steels, etc. It is especially useful for the reclaiming of stainless steel scrap. The variety of applications of resistance furnaces is exceedingly wide. Stated briefly, they are in operation for most processes which require accurate temperature and atmosphere control and where the cost of heat treatment is subsidiary to the improvement of the quality of the product. For many purposes and in many circumstances electric heating is competitive with other forms of heating on a straight cost basis. WH (6)



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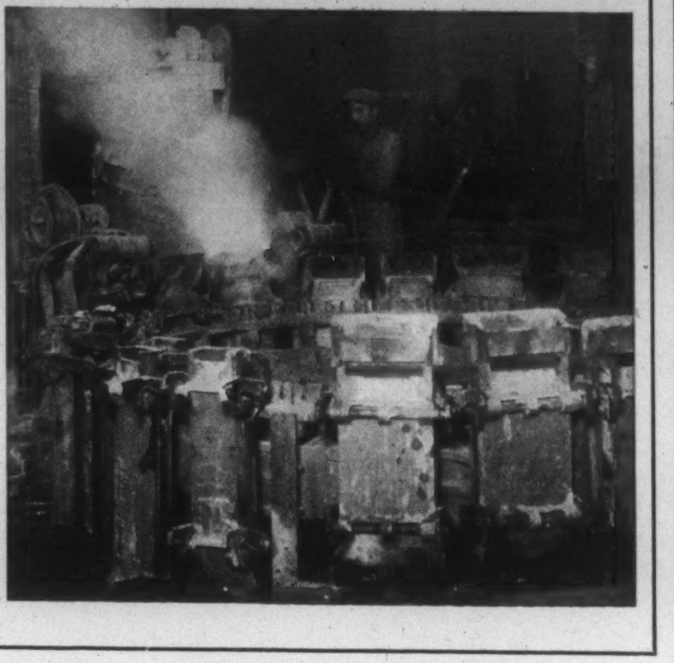

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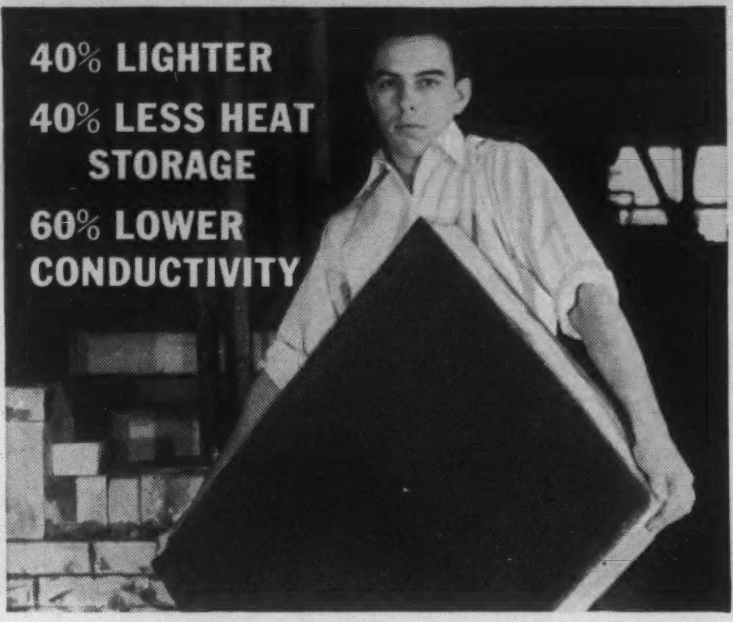

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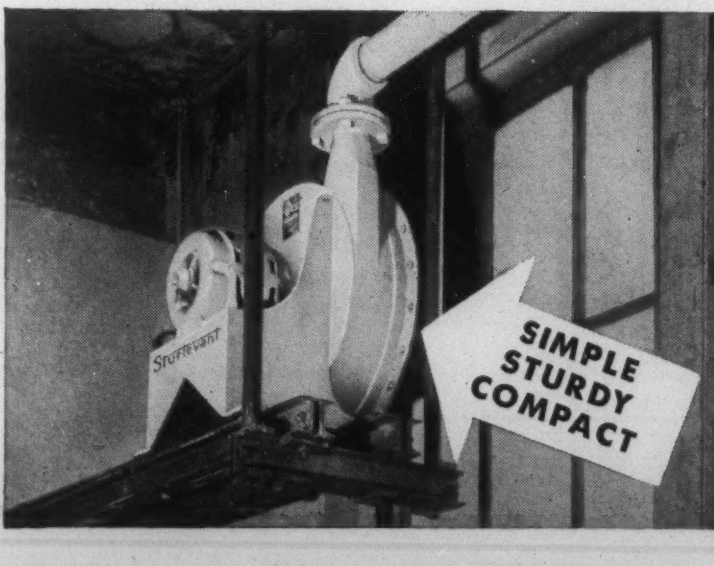

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Brackelsberg Furnaces. WALTER ALBERTS. *Heat Treating & Forging,* Vol. 21, Feb. 1935, pages 94-97; Mar. 1935, pages 141-143. Discusses advantages of the Brackelsberg furnace for melting metals and gives results of tests made by P. Bardenheuer on melting of steel in the furnace *(Stahl und Eisen,* Vol. 50, Sept. 18, 1930, pages 1328-1330; *Metals & Alloys,* Vol. 2, Feb. 1931, abstracts, page 42) and of tests made by P. Bardenheuer and K. L. Zeyen on melting of malleable and gray cast-Fe *(Mitteilungen aus dem Kaiser-Wilhelm-Institut für Eisenforschung,* 1929, Vol. 11, No. 14, pages 237-246; *Metals & Alloys,* Vol. 1, Dec. 1929, page 293.) MS (6)

Constituents and Properties of "Radex" Magnesite Brick. P. P. BUDNIKOFF & B. J. PINES. *Journal American Ceramic Society,* Vol. 18, Apr. 1935, pages 125-127. Radex brick is a new product of the Austrian-American Magnesite A-G and is a magnesite brick which the manufacturer claims to be free from the principal difficulty with ordinary magnesite brick, i.e. easy formation of cracks. Radex withstands over 30 repeated heatings to 950°C. followed by quenching in cold, running water. Physico-chemical data are reported, macro and micro structure discussed and shown in text and X-ray investigation results tabulated. The brick is highly resistant to basic slag and has high spalling resistance under rapid temperature fluctuations. WB (6)

Steelworks Installs New Soaking Pit and Crane Equipment. L. E. BROWNE. *Steel,* Vol. 96, Apr. 29, 1935, pages 45-46. American Steel and Wire Co. has installed at its South Works, Worcester, Mass., two 4-hole, 1-way oil fired soaking-pits. Firing port is in rear wall and fires toward front wall. Path of gases within hole resembles a vertical horseshoe. Waste gases pass through a 3-pass refractory tile recuperator. Recuperator is designed to preheat air to 1000°F. Suspended flat-arch type insulated pit covers are used. Stripper crane handles all types of ingots. It is designed for a stripping pressure of 150 tons and a lifting load of 15 tons. MS (6)

Liquid Fuel and the Heat Treatment of Steel. D. A. WHITEHEAD. *Heat Treating & Forging,* Vol. 21, Feb. 1935, pages 89-93, 97. From paper read before the Steel Treatment Research Society, Australia, Nov. 1934. Deals with characteristics of fuel-oil, combustion, methods of burning, automatic control, and forging and heat treating furnaces. MS (6)

Industrial Electric Heating. XXI. Gray Iron. N. R. STANSEL. *General Electric Review,* Vol. 37, Sept. 1934, pages 416-421. If the molten cast iron is heated to 2800°-3000°F. and held for a brief period of time suspended particles of graphite are completely dissolved and the cast iron will have a better structure and better physical properties. The electric furnace is useful in gray-iron foundries because of the following features: (1) The ability to raise the temperature easily and quickly and to hold the charge at the required elevated temperature. (2) Gray iron of any C content can be produced with uniform results. (3) Any composition of alloy is reproducible. (4) Charge is not subject to contamination during melting. (5) The atmosphere of the furnace can be either reducing, oxidizing, or neutral as needed. (6) The melt can be refined or the composition can be altered by additions. (7) Gray-iron heats, malleable-iron heats, or steel heats can be run in any order to suit production schedules. (8) The electric furnace can be adapted to melting cold charges or for duplexing. (9) Scrap metal of all sizes can be melted. (10) A wide range of sizes of furnace units is available. The main items in the cost are: energy, electrodes, refractories, maintenance, and labor. Costs vary with the size of the furnace, rate of melting, max. temperature of the charge, extent of refining, length of holding period, continuity of operation, individual price schedules, etc. CBJ (6)

Modern Crucible Melting Equipment. R. H. STONE. *Industrial Heating,* Vol. 2, Apr. 1935, pages 181-186. Advantages of crucible melting in particular for non-ferrous metals, consisting in low investment, wide choice of fuels, flexibility as to kinds of metals melted and rate of operations and good quality of product are discussed at length and design, burners, metal produced, and costs of operation treated in detail. Ha (6)

Selection of Fuel for a Powdered Coal Machine (Auswahl der Brennstoffe für die Kohlenstaubmaschine). F. SCHULTE. *Stahl und Eisen,* Vol. 55, Apr. 18, 1935, pages 442-444. Lignite is better than coal because it has a lower ignition temperature. On the other hand, by the proper selection and preparation of coal it is possible to lower the ash content and thus reduce wear in the motor and improve its operation. SE (6)

Silicon Carbide Serves as Heat Exchange Medium. H. L. READ & F. L. FRITSCHE. *Steel,* Vol. 96, Feb. 25, 1935, pages 39-41, 44. For minimizing cracks and leakage in refractory recuperators, a joint has been developed which allows a slight movement in the setting. Silicon carbide is a satisfactory material for recuperators because of its extremely low cracking and spalling tendencies and great strength and thermal conductivity at high temperatures. Rate of heat transfer is greater than with other refractories due to the higher air velocities, without serious leakage, which can be used. Describes some applications to steel-mill furnaces. MS (6)

Heat Treatment and Paint-Drying by Inductive Heat. H. G. REMMERS. *Metals & Alloys,* Vol. 6, Apr. 1935, pages 85-86. Describes the application of inductive heating to treatment of razor blade steel, local or "differential heat treatment," heat treating tubing and to paint drying. WLC (6)

Basic and Acid Hearths for Copper Refining Furnaces (Basische und saure Herde in Kupferraffinieröfen). E. T. RICHARDS. *Chemiker-Zeitung,* Vol. 59, Feb. 6, 1935, pages 115-117. While most hearths are acid, some large American refineries use magnesite supported on fire brick. Magnesite does not corrode or absorb as much Cu as SiO_2, but is very sensitive to temperature changes, especially in new hearths. Neutral chrome ore and chrome mineral linings are less sensitive to temperature than magnesite and have good corrosion resistance, but they absorb more Cu than magnesite. It is difficult to recover Cu from both magnesite and Cr linings. Basic fire brick hearths are used for only a few blister and white Cu furnaces. Quartz hearths are better for large installations than silica sand if they are properly constructed. Impurities in the quartz often cause difficulties in Cu recovery. Up to 30% of a sintering material should be used with sand, preferably Cu scale, or a mixture of scale and Cu slag, or clay. Recommended method of initial heating is given. CEM (6)

7. JOINING

7b. Welding & Cutting

C. A. McCUNE, SECTION EDITOR

Welding—Selective or Out-of-Face. C. B. Bronson. *Railway Engineer & Maintenance,* Vol. 31, Mar. 1935, pages 166-167. Every battered rail joint represents an individual problem. It must be determined first whether the hard riding of the track results from pumping joints or poor ballast and whether the joint bars are doing their share of distributing the loads from one rail to the adjoining rail on each side. On the New York Central Lines, the problem is not so much a matter of rail batter as of correcting loose or worn joint bars. As a corrective measure the bars are reversed first. Leveling of a few high spots often demonstrates that the true batter is less than 1/64" on either rail end. Grinding will also remove the baffling bright spots at or near the end of the receiving rail. Finishing the joint with a bevelled cross slot will remove the remaining source of trouble, namely chipping. Cross slotting the ends of new rail after it has received an initial cold rolling for 6 months is necessary. Built-up welding of battered rail ends should be the last thing to be considered. WH (7b)

Shoes and Saddles for St. Lawrence River Bridge Gas Cut and Welded. David Boyd. *Steel,* Vol. 96, Mar. 11, 1935, pages 47, 49. Brief description of fabrication from steel plates. MS (7b)

Welding of Nickel and its Alloys (La Soudure du Nickel et de ses Alliages). A. Boutté. *Revue de la Soudure Autogène,* Vol. 27, Apr. 1935, pages 6-7. Weldability of Ni is dependent upon S and Mg contents in the metal. It has been established that Ni in which $\frac{Mg\% - 0.02}{S\%} = 4\text{-}5$ has a good weldability if S is less than 0.02% and if Si = 0.15-0.2%. Si is necessary as deoxidizer to prevent loss of Mg. Welding of Ni is preferably done with a torch capacity of 125 l.C_2H_2/hr./mm. thickness to be welded. The flame of the torch must be perfectly neutral because C is soluble in Ni up to 0.4% after which it is present as graphite which impairs ductility and because O causes a loss of Mg. When plates are thicker than 4 mm. they must be beveled at 90°. Added metal can be cut in the plates to be welded but a Ni with a small Ti content gives better results. The new alloy "Inconel" (Ni = 80, Cr = 14, Fe = 6) is said to have a perfect weldability. All fusion welding processes can be resorted to for Inconel. Attention is however drawn to the fact that this alloy has a very low ductility in the hot condition. Torch used must have a capacity of 75 l./hr./mm. FR (7b)

The Effect of Welding Variables on the Physical Properties of Electric Arc Weld Metals. Robert Rutherford Blackwood. *Transactions & Journal of Institution of Engineers of Australia,* Vol. 6, Nov. 1934, pages 421-443. An extensive study of the effect on the physical properties of 18 (analyses given) deposited electric arc weld metals of electrode gage, size of run, welding current and plate thickness. The effect of these variables on Brinell hardness, yield point, ultimate tensile strength, elongation, reduction of area, Izod impact value are investigated. Statistical methods are used in analyzing the wealth of data. The Izod impact values obtained from 10 mm. and 9 mm. test pieces are identical when the bottom of the notch is cut 8 mm. from the back of the test piece in each case. The testing temperature has no effect on the Izod impact value of weld metal above 40° F. A marked drop takes place below 40° F. The standard deviations of the physical properties of weld metals were as follows: yield point stress: —7.15% of the mean value; tensile strength: —7.28%; elongation: —25.6%; reduction of area: —24.6%; Izod impact value: —19.5%. The welding current (used within the practical range) had no significant effect on the physical properties of the weld metals for all run sizes and plate thicknesses used. For an ordinary mild steel weld metal (A) containing 0.05 C, 0.06 Mn, 0.04 Si, there is a reduction in yield stress (10.2%), ultimate (5.2%) and Izod impact strength (31.6%) when increasing the plate thickness from ⅜" to ¾" but no change in elongation and reduction of area. These physical properties are not impaired under the same conditions when utilizing an 0.1 C, 0.71 Mn, 0.5 Si, 0.34 Cr weld metal (B). The impact value is even increased 10.8%. Increasing the electrode gage of (A) and (B) for the same size of deposit, slightly reduces yield stress and tensile strength. No change in elongation and reduction of area. Increase in electrode gage for the same size of deposit results in a marked increase in Izod impact value for (A) and a reduction with (B). Increase in size of run for a given electrode gage results in a slight rise in yield stress and ultimate tensile strength, in no change in elongation and reduction of area and in a very significant decrease in Izod impact value with (A). Under the same conditions (B) exhibits a slight decrease in yield stress, and ultimate tensile strength, no change of the plastic values and a slight decrease in Izod impact values. 24 tables and 34 diagrams accompany this paper. WH (7b)

Modern Electric Welding (Neuzeitliche Elektro-Schweissung). Jöllenbeck & Scheffel. *Borsig Mitteilungen,* 1934, No. 3, pages 5-7. States that electric welding advanced at a faster rate in the U.S.A. and England whereas Germany was leading in the development of water-gas welding. Test results on a welded boiler plate of 44-53 kg./mm.² submitted to tensile, notch impact and bending tests in the as welded and annealed state (650°, 850°, 920° C.) are tabulated. The potentiality of welding is demonstrated by four giant pressure vessels assembled and equipped by electric welding. WH (7b)

Tests Show Constant Time Is Chief Factor in Spot Welding Work. Warren C. Hutchins. *Steel,* Vol. 96, Mar. 4, 1935, pages 52,54. To minimize effects of all variables encountered in spot welding, time during which power is supplied for making each weld should be accurately duplicated. General Electric Co. uses thyratron controls on many welders and uses a less expensive time control on all others. MS (7b)

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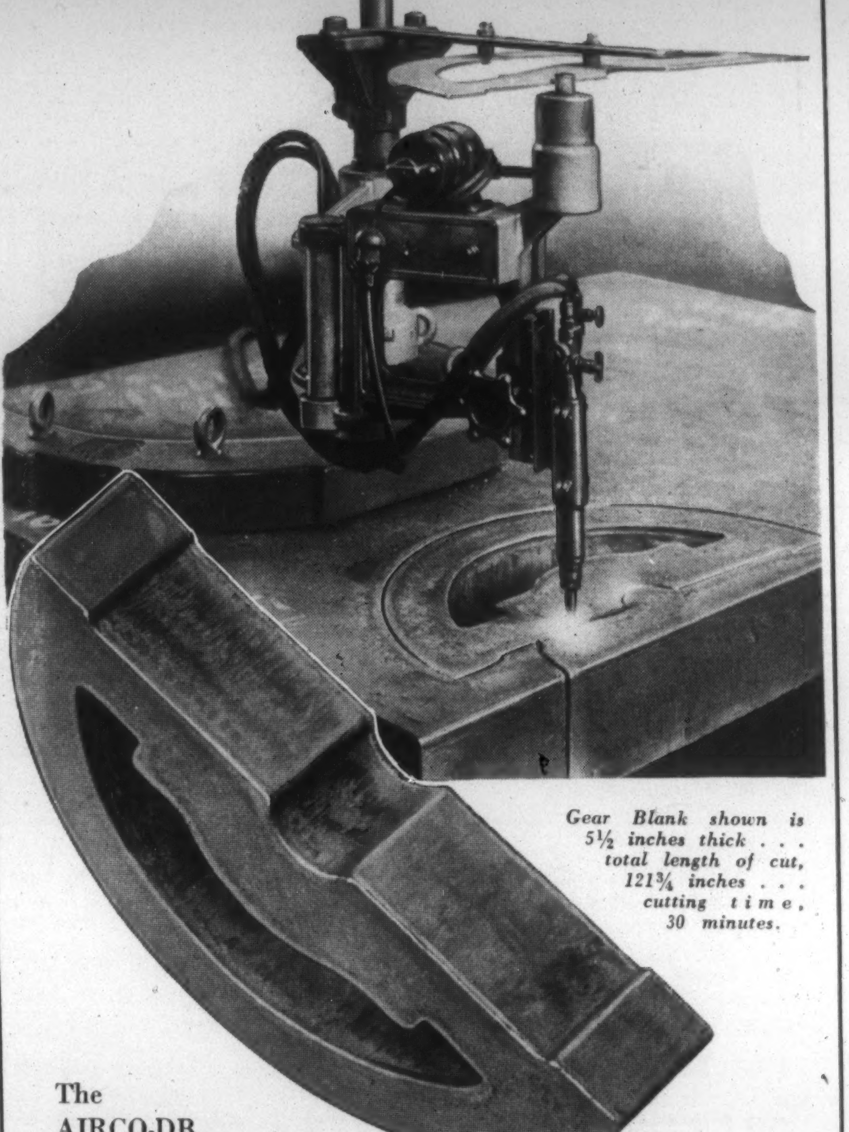

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Application of New Oxy-Acetylene Welding Method (L'Application des Nouvelles Méthodes de Soudure Oxy-Acétylénique). R. Meslier. *Revue de la Soudure Autogène,* Vol. 27, Mar. 1935, page 9. Typical application of "double seam welding" is illustrated in the work of transformation of locomotive frames made of 32 mm. thick plates. In this method, 2 operators weld simultaneously on each side of the plates with low power torches (30 l./hr./mm.). With method "B" edges of plates are not shaped. With method "C" they are X shaped. Method is said to be rapid, economical and dependable. FR (7b)

Comments on Specifications for Added Metal in Oxy-Acetylene Welding (Commentaires sur les Spécifications Relatives aux Métaux d'Apport pour Soudure Oxy-Acétylénique). Y. Mercier. *Bulletin de la Société des Ingénieurs Soudeurs,* Vol. 6, Jan.-Feb. 1935, pages 1674-1682. Lecture before the French Welders' Society. Explains how French specifications for added metals were established. FR (7b)

Welding Less Frequently Used Alloy Steels and Other Alloys in Welding. Miles C. Smith. *Steel,* Vol. 96, Mar. 4, 1935, pages 42, 44, 46, 48. To obtain good results in arc welding of alloys, coated electrodes should be used, in which alloying elements are in the body of the rod. Composition should be such that weld-metal, resulting from alloying of parent metal and electrode, will have desired composition and properties. Rod should be positive pole of d-c. arc circuit. Amperage to give proper temperature should give adequate penetration, and deposit metal with a smooth surface as rapidly as and no faster than desired. MS (7b)

Huge Mill Housing Successfully Welded. Merritt L. Smith. *American Welding Society Journal,* Vol. 14, Apr. 1935, page 4. 4 tons of thermit metal used for repairing 2 cracks. Entire operation required a week. WB (7b)

Electric Fusion Welding as Applied to Refrigerating Equipment. T. C. Schuyler. *Refrigerating Engineering,* Vol. 29, Apr. 1935, pages 188-192. A general survey of the welding industry and the construction of refrigerating equipment by welding. Stress relieving of welded vessels is considered very necessary for service conditions which may include exposure to temperatures of —200° F. The best practice for alloy steel welding is suggested. WB (7b)

Welded Steel Frames for Marine Engines. C. H. Stevens. *Electrical Review,* Vol. 116, Feb. 15, 1935, page 242. Abstract of paper read before the Institute of Marine Engineers, Feb. 12, 1935. Discusses design and construction. MS (7b)

The Present Status of Welding in Shipbuilding. J. Lyell Wilson. *Marine Engineering & Shipping Age,* Vol. 40, Apr. 1935, pages 150-151. Abstract of a paper read before the American Welding Society, New York, Mar. 12. Deals with welded joint efficiency, operating technique, electrodes, and base metal. Kz (7b)

Spot-Welding. K. B. White. *Wire & Wire Products,* Vol. 10, Apr. 1935, pages 143-144, 156. The welding characteristics of 250 combinations of wires were studied and are shown in a table which indicates what kind of weld, if any, is possible between any 2 wires. Ha (7b)

On Artistic Craftsmanship (Aus dem Kunsthandwerk) Victor Walter. *Autogen Schweisser,* Vol. 8, Feb. 1935, pages 17-20. Application of flame cutting and gas welding in creating artistic ornaments. Kz (7b)

Largest Electrically Welded Bridge in the World (De grootste electrisch gelasschte brug ter wereld) R. W. P. Leonhardt. *Polytechnisch Weekblad,* Vol. 28, Dec. 13, 1934, pages 785-788. See "Details of Design and Construction of the World's Largest Welded Bridge," *Metals & Alloys,* Vol. 5, Nov. 1934, page MA 525. WH (7b)

Welded Steel Structures—Recent Developments in Europe. A. Ramsey Moon. *Structural Engineer,* Vol. 12, Nov. 1934, pages 464-473. Paper before the Institution of Structural Engineers, London, Nov. 1934. See *Metals & Alloys,* Vol. 6, Apr. 1935, page MA 154. WH (7b)

Development and Progress of Bronze Welding (Développement et Progrès de la Soudo-Brasure). R. Meslier. *Bulletin de la Société des Ingénieurs Soudeurs,* Vol. 6, Jan.-Feb. 1935, pages 1631-1644; *Revue de la Soudure Autogene,* Vol. 27, Feb. 1935, pages 7-12.

Lecture before the French Welders' Society. (1) Malleable cast Fe: bronze welding is the only method available for repair of malleable castings. Very often a recovered casting is more resistant than the original one. (2) Steel: Process is very suitable for inside angle joining as in the case of flanges on bodies. Bronze welding is largely used for filling the groove on the opposite side of plate welded on fold edges. Method is also applied for joining tubes with outside sleeve and for ornamental works. (3) Zn coated steel plates: process can be resorted to without any difficulty, resistance to oxidation is preserved because Zn coating is fused but not volatilized. (4) Bronzes: Numerous bell repairs have been made with complete success. (5) Cu: Bronze welding gives good results particularly for joining thin plates. Method naturally gives a heterogeneous joint which is not suitable for some chemical uses. For brass alloys the contrary is true; plates of thickness higher than 4 mm. can easily be bronze welded. Bronze welding is particularly interesting for building up worn parts as in the case of turbine wheels. FR (7b)

Profiles of Welded Butt Joints. J. Orr. *Mechanical World & Engineering Record,* Vol. 97, Mar. 15, 1935, page 252; Mar. 22, 1935, page 278; Apr. 12. 1935, pages 349-350. **Stresses in Welded Joints.** *Electrical Review,* Vol. 116, Feb. 22, 1935, page 274. Abstract of a paper "Electric Arc Welding in General Engineering," presented to the Institution of Engineers and Shipbuilders. An objection to the profile of a single or double V for a butt joint is the difficulty of ensuring complete penetration of the root. This trouble is minimized by adopting a J profile. Discussion of bend and tensile tests. Experiments were carried out to determine the residual stresses after welding firmly-held plates. A formula is given applicable to similar conditions. Presentation of test results on welds of various high-tensile steels for which different electrodes have been used. The effects of machining and annealing are discussed. The weld material is more affected by annealing than is the parent metal. The ultimate tensile strength is decreased slightly while the ductility is increased. MS + Kz (7b)

Stress-Relieving Welded Pipe Joints By 60 Cycle Induction Heating. A. F. Frugell & D. H. Corey. *Journal American Welding Society,* Vol. 14, Mar. 1935, pages 17-18. A simple method of heating the welded pipe joint in place is shown. It consists of an insulating shield placed around the pipe and several turns of wire wound on the sleeve to form the induction coil of a secondary tap. The outfit can be used for pipe welds up to 16" diam. with a 75 Kva transformer having 230 volts across the primary and 25 secondary taps to give 11 to 107 volts across the coil taps. In stress-relieving welds, too rapid rise to the final temperature of 1100°-1300° F. is avoided by decreasing number of ampere turns at the start. The energy required was 3 kw. hr. for a 2½" pipe weld, 13 kw. hr. for 8" and 27 kw. hr. for 16" pipe weld with the rate of heating variable and controllable at will. For pipe larger than 16" the same type of outfit could be used but with larger capacity transformer. WB (7b)

High-Quality Gas Fusion Welding and its Application in Practice (Hochwertige Gasschmelzschweissung und ihre Anwendung in der Praxis) H. Frankenbusch. *Autogene Metallbearbeitung,* Vol. 28, Apr. 1, 1935, pages 97-103. High-grade gas welding in which 100% strength of the base material, high elongation and notch-toughness of 15-20 kg./cm.^{2} are obtained, is used in manufacture of boilers, apparatus and also for very thick plates, e.g. galvanizing baths, tanks for tinning, salt baths, etc. Selection of location of weld, of material, shape of tanks, kind of seam, are discussed and welding procedures illustrated. Ha (7b)

Gas Welding and Silver Soldering Monel Metal and Nickel. F. G. Flocke & J. G. Schoener. *Welding Engineer,* Vol. 20, Apr. 1935, pages 17-20. Practice and procedures of oxy-acetylene welding of Ni and Monel metal are explained and examples illustrated. The welds are very satisfactory. Pipes and tubes are silver soldered. The joints are immune to many corrosive conditions. Ha (7b)

Fusion Welding of Tools (Werkzeugreparatur mit dem Schweissbrenner). Ernst Greger. *Autogen Schweisser,* Vol. 8, Mar. 1935, pages 30-33. Discussing examples some practical advice in the gas welding of tools is given. Kz (7b)

Review of Work Done during 1934 by Companies Concerned with Fusion Welding (Compte Rendu des Travaux des Organismes de l'Acétylène et de la Soudure Autogène en 1934). R. Granjon. *Revue de la Soudure Autogène,* Vol. 27, Feb. 1935, pages 2-3. Two books "Expansion and Shrinkage in Fusion Welding" (Dilatation et Retrait en Soudure Autogène) by Marcel Piette and "Crystallization of Metals and Alloys" (La Cristallisation des Métaux et Alliages) by Colonel Belaiew have been published. FR (7b)

Recent Progress in Fusion Welding (Les Progres Recent de la Soudure Autogene). R. Granjon. *Bulletin de la Societe d'Encouragement,* Vol. 134, Apr. 1935, pages 187-203. A general review of fusion welding and the improvements brought about in mechanical properties of welded joints in various structures by the metallic or structural continuity obtained with the newer controlled methods. Numerous mechanical structures are illustrated and discussed in showing how and why oxy-acetylene and arc welding has replaced other methods of joining and fabrication. WB (7b)

Deseaming (Syrgashyvling). Bo Gorthon. *Teknisk Tidskrift,* Vol. 65, Mar. 23, 1935, pages 123-124. Describes the oxygen torch used in deseaming. A gas pressure of 2-7 atm. is generally used, with an oxygen consumption of 7-23 m.^{3}/hr. and an acetylene consumption of 0.4-1.2 m.^{3}/hr. Efficiency is about 15% higher and cost 30-40% less than obtained with ordinary cutting torches. Working speed generally 3-10 m./min. BHS (7b)

Through the Near East with a Welding Gang. R. M. Gooderham. *Oil Weekly,* Vol. 76, Feb. 18, 1935, pages 39-42. Application of arc welding in pipe line construction. Kz (7b)

The Repair of Small Boilers. F. A. Glidewell. *Steam Engineer,* Vol. 4, Apr. 1935, pages 288-290. Presented before Junior Institution of Engineers. Electric welding is superior to oxy-acetylene welding for boiler repairs. The points most likely to need repair in various types of boilers are discussed. AHE (7b)

Welding in Swedish Industry (Svetsning i Svensk Industri). *Teknisk Tidskrift,* Vol. 65, Mar. 23, 1935, pages 95-122. A general symposium on welding with examples of Swedish practice, consisting of the following articles: Short History of the Welding Technique (Kort Historik över Svetstekniken) by Frithiof Holmgren; Control in Arc Welding (Kontroll vid Baagsvetsning) by Otto Hallström; Education in Gas Welding (Naagot om Utbildning i Gassvetsning) by Karl Boström; Use of Electric Welding by General Swedish Electric Co. (Den Elektriska Svetsnings Användning inom A.S.E.A.) by Gösta Hall. Acetylene-Oxygen Welding by A. B. Gas Accumulator (Acetylen-Syrgassvetsningen vid A.G.A.) by H. Spiegelberg. Welding in Air Craft Construction (Svetsning av Flygplanskonstruktioner) by Henry Kjellson; Welding in the Construction of the Vipeholm Hospital in Lund (Svetsning av Byggnadsstomme vid Vipeholms Sjukhus i Lund) by Ernst Lindh; The Importance of Welding in the Construction and Upkeep of Artillery Material (Svetsningens Betydelse for Nytillverkning och Underhaall av Artillerimaterial) by Nils Dyrssen; Welding at A. B. Swedish Railroad Shops (Svetsning vid A. B. Svenska Järnvägsverkstaderna) by Bo Lundberg; Use of Welding at Karlsberg Machine Shops (Användning av Svetsning vid Karlsberg Mekaniska Werkstad) by E. A. Einstler. The All-Welded Paalsund Bridge in Stockholm (Den Helsvetsade Paalsundbron i Stockholm) by D. Arvidson. BHS (7b)

Gas Welding of a Fire Tube (Die Gasschweissung bei einer Flammrohr-reparatur). Ernst Greger. *Autogen Schweisser,* Vol. 8, Jan. 1935, page 8. Parts of the fire tube of a flue boiler were corroded to such an extent that the boiler would not have passed the next inspection. The parts in question were cut out with the flame cutting process and replaced by new sheets which were welded to the fire tubes by oxy-acetylene welding. Kz (7b)

Use of Oxy-Acetylene Welding in Rail Construction (L'Emploi de la Soudure Oxy-Acétylénique sur les Voies Ferrées). R. Meslier. *Revue de la Soudure Autogène,* Vol. 27, Apr. 1935, pages 8-9. Reviews typical well known applications. FR (7b)

Work and Research in Welding (Travaux et Recherches en Soudure). *Revue de la Soudure Autogène,* Vol. 27, Feb. 1935, page 14; Mar. 1935, page 18; Apr. 1935, page 15. Short account of research in progress at the Office Central de l'Acétylène. Part I deals with (1) Expansion and shrinkage of welds: apparatus has been designed for this study. Data will be soon available which will enable computing distortions in metals and controlling them by correct practice. (2) Selection of torch capacity: this capacity affects cost and quality of welds. Best results have been obtained with torches of 100 l.-hr./mm. of thickness to be welded. (3) Micro-mechanical tests of welds: micro-testing machine of the Chevenard type has been installed in the "Office Central de la Soudure Autogène" with which studies on properties of welds are already in progress. Numerous tests will be made on each joint and will enable drawing conclusions on local variations and means to prevent them. Part II discusses (1) Micro-mechanical study of welded joints: first results obtained have given the thermal effect in each layer and stresses in arc welding of thick plates. Much is hoped from this new method of investigation. (2) Welding of rails: Tests have shown that it is possible to obtain good static and fatigue strengths on the joints. (3) Control of welding equipment: manufacturers can obtain from the "Office Central de l'Acétylene" characteristics of their apparatus in the form of definite figures which cannot be contested. Part III. (1) Study of electrodes for resistance welding machines: bears on Be-Cu which has a hardness 15% higher, question is whether advantages make up for extra cost. (2) Welding of "Alumag." Good welding is obtained by correct preparation of edges which must be slightly beveled on opposite side of welding so that problem did not concern the flux as thought previously. FR (7b)

Welded Steel Hopper Wagons. *Railway Engineer,* Vol. 55, Jan. 1935, page 406. Describes and illustrates the light-weight all-welded hopper wagons recently built at the Utrecht shops of Werkspoor N. V., Holland. The cars are entirely arc-welded not a single rivet being used. The usually unavoidable process of straightening out was virtually eliminated by slightly setting the parts in the opposite direction before welding was begun. Alternately certain parts were held rigid by means of heavy framing till the welds were cold. Every weld was laid in a horizontal position. WH (7b)

Czechoslovak Welding Specifications for Steel Constructions (Tschechische voorschriften voor gelaschte staalconstructies). *Polytechnisch Weekblad,* Vol. 29, Apr. 12, 1934, page 239. Whereas the German standards DIN 1400 do not specify the welding method for soft structural steel, the new Czechoslovak standards CSN 1120 call for electric arc welding. Under dynamic stresses, the permissible stress is about 15% lower than for DIN 1400. The new specifications do not permit rivets, bolts and welds to be used in the same joint. WH (7b)

The Carbo-Flux Method of Welding Thin Sheets. *Mechanical World & Engineering Record,* Vol. 97, Mar. 1, 1935, pages 201-202. Abstract from Asea Journal (Allmänna Svenska Electriska A. B. Sweden). A magnetic field is used to control the arc from a carbon electrode and prevent its otherwise unrestrained movement about the weld. The method discussed permits of welding sheets down to a thickness of 0.5 mm. When special filling wires and fluxes are used to obtain the steady arc which characterises this method Cu, Al, and its alloys as well as alloy steels can be welded. Kz (7b)

Bronze Joints for Copper. H. L. FETHERSTON. *Journal American Welding Society,* Vol. 14, Apr. 1935, pages 2-4. Fabrication of Cu pipe from sheet by butt welding with bronze rod. Steel and Van Stone flanges joined to pipe and tested hydrostatically to 100 lbs. without failure. Van Stone type joint was then used because of lower cost. Corrosion resistance of bronze weld had to be considered for paper pulp digester pipe exposed to H_2SO_3 and SO_2 in high concentrations. Tests showed that bronze weld if properly made is not attacked to any greater extent than is the Cu pipe itself. Electrolytic action at the junction of dissimilar metals was found to be negligible where the metals are joined by welding, because of good electrical conductivity. Only where the dissimilar metals are held together by mechanical means is there an anodic action on one of the metals of the joint. Service tests of a year's duration on pipe carrying paper pulp stock through 3 stages of beating, screening to paper-making machines have shown satisfactory results. Most of the pipes are 10" in diam. but there also are some of 12" and 6" diam. The use of jigs in setting up the Cu sheet to be welded longitudinally is discussed, and the time for an 8 ft. seam after some practice now averages 20 minutes including handling, placing in and removing from the jig. WB (7b)

The Arc Welding of Cast Iron. A. F. DAVIS. *Journal American Welding Society,* Vol. 14, Apr. 1935, pages 29-32. Cast iron is being successfully welded at present in a wide range of applications by means of electric arc process and a specialized welding technique. Welding in intervals and allowing areas to cool is considered to be the largest contributor to the success of the special technique. This prevents overstressing adjacent sections from high local heating in the welding zone. When using metallic arc and steel electrodes the dangers are that the contraction of the weld metal after deposition will stress the cast iron on both sides of the bead, also that the absorption of C by the weld metal from the cast iron and rapid cooling will produce a hard, difficultly machinable weld. To prevent cumulative strain in the cast iron from a long bead of weld deposited steel, the weld bead is interrupted and allowed to cool or is laid on in a sinosoidal curve fashion. A third method is to hammer or peen the weld while still hot. In cases where the welded cast iron product does not require machining the procedure is simply as cited above while if machining is necessary the entire casting must be heated and slowly cooled after welding. The reason why this procedure is required is that the cast iron increases its combined C at the expense of its graphite C and the steel weld absorbs C from the cast iron during the welding operation thus forming 2 difficultly machinable products. Coated electrodes are an advantage in reducing hardness due to the lower thermal requirements with this rod. Some cast iron welds have been made with heavily coated 18-8 rod with .07 C max. The C arc with cast iron filler has also been used in which case the oxide can be floated off and the C arc used to prevent rapid cooling and production of hard spots. The cast iron electrodes are not generally used because of the hard weld usually produced by their use. Non-ferrous electrodes produce machinable welds which do not absorb C from the cast iron but the same precautions as above are necessary otherwise a hard material is produced in the cast iron back of the non-ferrous weld. Several salvage jobs on expensive cast iron apparatus of large size are discussed and illustrated in photos. WB (7b)

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Tensile Strength	86,000 p.s.i.	Reduction in Area	64%
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8. FINISHING

H. S. RAWDON, SECTION EDITOR

8a. Pickling

Pickling Problems. J. W. Jenkin. *Iron & Coal Trades Review,* Vol. 130, Feb. 22, 1935, page 339. Discussion before the Midland Metallurgical Societies of problems connected with pickling ferrous and non-ferrous metallic materials. The fundamental reaction of the pickling of iron is $FeO+2H=Fe+H_2O$; the rate of the reaction depends on time, temperature and concentration of pickling acid. Mechanism of scale removal is the same, whether HCl or H_2SO_4 is used. The acid acts through pores and cracks in the scale. The principal results of a series of experiments are summarized and show that within limits it is more important to control temperature than acid concentration, the choice of the acid being decided by economical considerations. Maximum economy in acid results from reducing "spent liquor" losses, and for each given condition it is possible to establish a routine practice based on initial concentration of liquor, temperature, maintenance and finishing. Average obtained in 8 different plants was about 0.5-0.7 lbs. of acid for each 1000 ft.^{2} Inhibitors or restrainers were found to be all of the same order of efficiency, about 95%. Inhibitors should be used not merely to save acid but also to insure against overpickling and waste of valuable material. Although a number of practical processes for making ferrous sulphate have been worked out, acid recovery is still a debatable question. Bulk storage of acid is economical instead of buying acid in carboys. Pickling of stainless steel is not so simple as simple steels, an electrolytic action between scale/acid/metal seems to go on. The most convenient pickle seems to be, in this case, a nitric-hydrochloric mixture. Phosphoric acid pickling has been employed economically in England and on the continent, the advantage being that the temporarily formed phosphates of iron protect the steel from further attack, and the pickled surface stays comparatively rust-free until painting can be done. Mechanical handling of materials for pickling is briefly discussed. If really bright-annealing could be done economically pickling might be done away with, although the rust induced by pickling is often a very good lubricant in cold-drawing operations. Ha (8a)

Cleaning of Condenser Tubes (Das Reinigen von Kondensatorrohren). Konrad Weiss. *Die Wärme,* Vol. 58, Jan. 5, 1935, pages 9-11. Critical discussion on chemical vs. mechanical cleaning of condenser tubes. Reports on laboratory tests which were translated successfully into service conditions. Author states that HCl is the most suitable agent for removal of the hard incrustations in condenser tubes. This method is the cheapest, requires the shortest time for cleaning, shows the least attack of the underlying metal and furnishes a "clean condenser." The expense for cleaning a 2000 m.^{2} condenser by milling and by pickling amounts respectively to 2150 RM and 310 RM. Photographs are shown exhibiting the accelerated corrosion attack due to cold work. Measurements revealed that the thermal efficiency of condensers cleaned with HCl is higher. EF (8a)

Continuous Pickler Rolls Are Faced With Rubber. W. E. Genung. *Steel,* Vol. 96, Apr. 15, 1935, pages 49-50. In continuous sheet pickling, rubber-covered steel rolls offer all the strength and rigidity of full size steel rolls plus a cushioned acid-resistant renewable surface. Roll core is constructed of sheet with head, neck and journal assembly as a single steel casting. Heads are shrunk and welded in place, and are hollow as are the necks. Vent holes (necessary for vulcanization) are drilled through center of journals to provide unbroken covering surface. Medium density rubber is used for covering. Direct rubber-to-metal bond, such as the "Vulcalock" process, prevents seepage of acid under rubber in case of puncture. For submerged rolls, cores with Monel, stainless steel, or other suitable journals may be used with plain bearings, which must be resistant to the particular acid. Squeeze rolls are similar in principle to those used in scrubbing machines. MS (8a)

Electrolytic Cleaning & Pickling. W. R. Meyer. *Monthly Review American Electro-Platers' Society,* Vol. 21, Nov. 1934, pages 37-40. Mentions a variety of conditions and actions that take place in cleaning and pickling. GBH (8a)

Equipment Designs for the Pickle House. *International Nickel Co., Bulletin,* 24 pages. Contains dimensioned drawings of pickling equipment and tables of mechanical properties of Monel metal in mill forms. (8a)

Pickling and Stress in Steel Castings. R. A. Bull. *Metals & Alloys,* Vol. 6, Apr. 1935, page 106. Discussion of article on this subject by Briggs and Gezelius, *Metals & Alloys,* Vol. 6, Feb. 1935, pages 39-40. WLC (8a)

8b. Cleaning, including Sand Blasting

Dry Cleaning Machine for Strip Steel. *Compressed Air Magazine,* Vol. 39, Oct. 1934, page 4558. Discusses process for removing oxide scale from hot rolled, annealed or tempered steel sheets, bands, strips, bars, tubes and wire by a dry cleaning process based on the principle of the sand-blast. It differs in that the metal is subjected to scouring and not to blasting, the medium employed being steel grit or shot carried in suspension by low-pressure air. It replaces acid pickling "which is so destructive to material, plant and equipment." A machine handling 2,500 lbs. of steel strip per hour is illustrated. WH (8b)

Gravel Blasting: Practical Experiences and Economy (Kiesstrahlbläser Betriebserfahrungen und Betriebskosten). W. Kaiser. *Zeitschrift für Dampfkessel & Maschinenbetrieb, Die Wärme,* Vol. 58, Feb. 9, 1935, pages 75-78. Discussion of gravel blasting for the removal of coatings on tubes difficult to eliminate by other means. EF (8b)

8c. Polishing & Grinding

Polishing and Buffing Operations in Electrical Manufacturing. Waldo Hutchinson. *Electrical Manufacturing,* Vol. 13, Oct. 1934, pages 26-28. Theoretical considerations and actual practice given for commercial polishing various metal plates. WB (8c)

8d. Electroplating

Black Chromium Plating (Die Schwarzverchromung). A. Pollack. *Chemiker-Zeitung,* Vol. 59, Jan. 16, 1935, page 56. A black Cr deposit is obtained by using 8 to 9 times the normal current density, 80 to 100 amps./dm.^{2} or more, at a temperature not over 15° C. The solution should contain 250 to 400 g./l. CrO_3 with the addition of acetic or some other organic acid instead of H_2SO_4. 11 to 14 volts are used and it is necessary to cool the solution to keep the temperature down. It can be plated with or without a Ni under coat. The Ni plate must be free from H and strains. Bright Cr coating followed by black Cr may be plated on an article so as to make it partly bright and partly black for use as a sign. Throwing power of black Cr is no better than that of bright Cr. Black Cr plate is very hard and is probably very fine grained metallic Cr. CEM (8d)

Cast Iron for Electrolytic Metal Deposition (Gusseisen für galvanische Metallniederschläge). H. Reininger. *Giesserei,* Vol. 22, Mar. 29, 1935, pages 149-150. The reason for the unsatisfactory adhesion of electro deposits on cast iron is graphite in the iron. It was shown experimentally that a Ni or Cu deposit could be easily pressed into the surface where graphite particles are under the deposit because they are embedded in the mass quite loosely. For satisfactory deposits the graphite in the cast iron should be as fine as possible. Ha (8d)

The Deposition of Zinc Cadmium Alloys from Alkaline Cyanide Solutions. L. Wright & J. Riley. *Journal Electrodepositors' Technical Society,* Vol. 10, 1934-5, pages 1-12. Paper read before the Society, Oct. 17, 1934. A high Zn solution, $Zn(CN)_2$ 11.6 g./l. (as Zn), total cyanide 35 g./l. (as CN), KOH 10 g./l. $Cd(OH)_3$ 3 g./l. (as Cd), cerelose 2 g./l., was operated at 8 amps./ft.^{2}, Zn and Cd anodes of equal surface being used. Cd in deposit was found to diminish with use; 15% at start, 9% after one week's operation, 6% second week, ½% one month. A high Cd solution is considered more stable; the solution contained $Zn(CN)_2$ 3 g./l. (as Zn), total cyanide 35 g./l. (as CN), KOH 10 g./l., $Cd(OH)_2$ 14.8 g./l. (as Cd), cerelose 2 g./l. Free cyanide used was KCN. Cd content of deposit was found to increase with temperature; KCN, increased; KOH decreased. Cd in solution invariably decreased, although less so when alloy anodes were used. Frequent additions of $Cd(OH)_2$ are required. Review is given of previous works on the subject. GBH (8d)

Solubility of Nickel Anodes (Der Lösungsprozess der Nickelanoden). Eugen Werner. *Die Metallbörse,* Vol. 24, Nov. 17, 1934, pages 1466-1467; Nov. 24, 1934, pages 1498-1499. Before the war, rolled and cast Ni anodes were used simultaneously in Ni plating baths to maintain the most suitable Ni concentration and acidity. Now, highly pure Ni anodes (99.5-99.9% Ni) are utilized and the current density is several times higher. Insoluble C and Pb anodes used during the war had many shortcomings. The rate of solution of Ni anodes is controlled by the electrolyte. Ni anodes in sulphate solutions become passive particularly at the higher current densities. The chemical reactions are fully discussed. The acidity of the electrolyte should increase simultaneously with the metal concentration. Activating salts, such as chlorates are added although they promote the formation of Ni superoxide-hydrate. Occasional rinsing with water restores the metallic surface of the Ni anode. Experiments proved that cast Ni anodes go into solution 3 times as fast as rolled ones. Practical instructions on the current control are furnished and recent tendencies to replace plate anodes by "edged anodes" (Kantenanode) are critically discussed. EF (8d)

Some Further Principles of Electro-Chemistry Applied in Electrodeposition. No. III. Anode Reactions. Samuel Field. *Electrometallurgy,* supplement to *Metal Industry,* London, Vol. 45, Oct. 5, 1934, pages 325-326. Anodes are divided into 2 classes; (1) soluble anodes which, under the influence of the applied potential difference, form ions and pass into solution; and (2) insoluble anodes which do not. Under (1) the author states that Zn liberates energy while Cu absorbs energy. Solution may also occur by corrosion of the anode by the electrolyte. which necessitates using insoluble anodes in some cases. The action in Cd solutions and the case of Cr anodes are cited. Under (2) antimonial Pb and C anodes are considered. Action in the case of a sulphate solution is outlined. The method of producing anodic films is discussed. Anodizing of Al and its advantages are indicated. Anode passivity is discussed and it is suggested that this may be due to the formation of an anodic film. Methods to overcome passivity of this kind are considered. HBG (8d)

Studies on Overvoltage. VIII. Overvoltage at Bright Platinum Electrodes in Two Normal Sulphuric Acid for Low Current Densities Determined with an Oscillograph. A. L. Ferguson & G. M. Chen. *Journal of Physical Chemistry,* Vol. 39, Feb. 1935, pages 191-198. Oscillographic studies were made of overvoltage phenomena at anode and cathode of bright Pt in 2 *N* H_2SO_4 and a comparison made between (A) direct method, (B) commutator method, (C) electromagnetic interrupter. A distinction is made between discharge curves due to (a) pure resistance (b) true polarisation and (c) both. EF (8d)

Platers' Guidebook. Oliver J. Sizelove. 4th edition. Metal Industry Publishing Company, New York, 1935. Paper, 5¼ x 8 inches, 65 pages.

A few selected plating baths for several of the commonly plated finishes are given, together with helpful hints of various kinds and an outline for the chemical analysis of plating baths. Where patented baths or processes are mentioned, the names are given of the firms who will license users. Brief comments are included on coloring silver, copper and brass, and on the anodic treatment of aluminum. While no subject is treated in great detail, the booklet will be useful.
H. W. Gillett (8d)—B—

Electroplating. Samuel Field & A. Dudley Weill. Pitman Publishing Corp., New York, 1935. Cloth, 5 x 7½ inches, 256 pages. Price $2.25.

Without going into vast detail, the theory and practice of electroplating is well covered in this volume, and the high spots of much recent work of practical importance are included. It is a really helpful handbook. The good impression given by the text is marred by the use of many repulsive illustrations, giving the impression of crude wood-cuts, evidently taken from the catalog of the English firm of Grauer and Weill, with which one of the authors is associated. Many of these are practically meaningless in respect to the text, and they bear the Grauer and Weill name prominently plastered on. It is unfortunate that so good a text carries propaganda of this type.
H. W. Gillett (8d)—B—

8e. Metallic Coatings other than Electroplating

Metal Spraying in Ship Building (Das Metallspritzverfahren im Schiffbau). P. Humann. *Werft, Reederei & Hafen,* Vol. 16, Feb. 1, 1935, pages 40-42. The coating of boiler members with Al is increasing in German ship building. The higher thermal efficiency of "alumetized" tubes is not only due to the absence of scale but also due to the higher thermal conductivity of Al. The life of steel tubes is considerably increased by Al coatings which are also specified for certain Cu and Mo steels used in superheater units because they retain their strength at elevated temperatures. Scaling is reduced by the Al-coating. Diesel engine pistons are also alumetized. Sprayed Al and Zn coatings are not suited for objects exposed to seawater corrosion. Cd coatings are coming into use instead; for instance on propeller shafts, Diesel engine walls in contact with seawater, buoys, filling material for cavitations in propellers. It is stated that maritime organisms do not form on sprayed Cd coatings which also offer a suitable base for additional paint coatings. Brief mention is made of spraying of welds of galvanized Fe sheets where the Zn coating evaporated during welding.
WH (8e)

The Metallizing of Plastic Masses. Lawrence S. Malowan. *Synthetic & Applied Finishes,* Vol. 5, Jan. 1935, page 246. For metal coating molded articles, various processes are available which vary according to whether the metal is applied before or after molding. A historical review is given including the application of metal under high pressure, with the aid of an adhesive, and the very successful spraying by Schoop's process. With the latter, difficulties arose in the case of very hard or smooth surfaces. A new German development circumvents these difficulties by a resinous intermediate layer. In contrast to this direct method of applying metallic coatings is the process whereby the surface of the plastic mass is changed chemically so that it is able to absorb and fix metals in colloidal form from appropriate solutions. Late developments along these lines are summarized, together with additional electro-deposited coatings and protective measures for areas not intended to be metallized. EF (8e)

Silver Coating of Mirrors by Cathodic Atomisation (Versilberung von Spiegelflächen durch Kathodenzerstäubung). M. Romanowa, A. Rubzow & G. Pokrowsky. *Physikalische Zeitschrift der Sowjet Union,* Vol. 5, No. 5, 1934, pages 746-760. Preparation of Ag mirrors and optical measurements.
EF (8e)

8f. Non-Metallic Coatings

Lackawanna Exhibits Aluminum-Finished Train. *Railway Age,* Vol. 98, Apr. 6, 1935, pages 540-541. Process of coating surfaces with Al paint called "Alumanealing." 15 minutes after application of a paint, which consists of the usual flake Al suspended in a heavy liquid, an oxy-acetylene flame is run over the surface to "set" the coating. Appearance of finished coat is satin and the process produces a hard film .003"-.005" thick. WB (8f)

How Attractive Finish Helps Metal Products Sales—26. Enameling and Lacquering. Herbert R. Simonds. *Iron Age,* Vol. 134, Oct. 25, 1934, pages 19-23. Problems arising in use of enamels and lacquers for metal parts are discussed together with information on durability, cost of lacquering, selection of coating, enameling steel sheets, lithographing enameled surfaces and relative advantages of enamel versus lacquer. VSP (8f)

The Anodic Oxidation of Aluminum and Its Alloys. S. Wernick. *Electrometallurgy,* supplement to *Metal Industry,* London, Vol. 45, July 20, 1934, pages 63-64; July 27, 1934, pages 79-82; Aug. 10, 1934, pages 131-133; Aug. 17, 1934, pages 151-152. Paper presented before the Electrodepositors Technical Society. A general discussion of anodic treatment of Al supplemented by experimental and other data. The paper deals chiefly with a discussion of the chromic acid and sulphuric acid electrolytes. The Bengough-Stuart chromic acid process and its limitations are described and also advantages and disadvantages of the sulphuric acid process. Theory of the formation of the oxide film is outlined and properties of the film are described. A method of determining the rate of formation and thickness of the oxide film is offered. The author's conclusions based on his tests on a large number of specimens of anodized Al are listed. The hardness, adsorptive properties, insulating properties, light-reflecting properties of the oxide film are discussed and some practical aspects of anodizing are considered. HBG (8f)

The Application of Bituminous Coatings. J. M. Fain. *Metal Cleaning & Finishing,* Vol. 6, Oct. 1934, pages 503-508. Bituminous materials may be applied as a solution in a solvent, in the molten state, or as an emulsion in water. Their application on pipe lines is described and specifications and methods of testing are given. GBH (8f)

Formation of a Film and Protection of Metal by Painting (Filmbildung und Metallschutz durch Anstrich). H. Wolff. *Korrosion & Metallschutz,* Vol. 11, Feb. 1935, pages 42-45. The conditions under which the film of oil paint is formed which protects the underlying metal from corrosion are discussed. Although definite knowledge of this process is lacking as yet, it seems that the formation of the film depends on drying conditions, and that eventual colloidal properties of the oil paints are of importance. Ha (8f)

Production Problems in Enameling Iron and Steel. Le Roy W. Allison & Malcolm B. Catlin. *Iron Age,* Vol. 134, Oct. 4, 1934, pages 21-27, 76, 78. Importance of basis metal in addition to composition of enamel is discussed. Character of service has a primary bearing in selection of materials and enameling procedure. Enamels for outdoor displays must resist atmospheric action and retain their original colors. Enamels for cooking ware must be free from harmful chemicals. Fundamental operations in porcelain enameling consist in forming the product, cleaning the rough piece, applying, drying and firing the ground coat, applying and firing the cover coat and finally inspecting, sorting, etc. Recent investigation on adherence of enamel to basis metal shows that during fusion of enamel and subsequent cooling, α-Fe crystals develop within the enamel, and it is likely that this needle structure tends to unite metal and glass. In considering the importance of steel and Fe for enameling, standardized and accurately controlled cupola practice is emphasized as the starting point of good cast Fe enameling. Defects such as blistering, black specking and bubbling receive some consideration.
VSP (8f)

Rapid Electrolytic Patina on Copper. G. L. Craig & C. E. Irion. *Metals & Alloys,* Vol. 6, Feb. 1935, pages 35-37. 5 references. In describing previous studies of the rapid production of patina on Cu it is suggested that though the analyses of natural patinas show them to be basic sulphate they first formed as basic carbonate which was converted to sulphate by SO_2 in the atmosphere. An electrolytic method of producing patina of basic carbonate in 2-10% solution of $NaHCO_3$ is described together with analysis showing that this carbonate changes to sulphate in a period of less than a year and independently of the season of the year. WLC (8f)

Strength and Young's Modulus of Some Ground-Coat Enamels for Sheet-Iron. W. N. Harrison, S. M. Shelton & W. H. Wadleigh. *Journal American Ceramic Society,* Vol. 18, Mar. 1935, pages 100-106. Eleven enamel compositions of the sheet-iron ground-coat type were studied. For 9 compositions, flint and feldspar were substituted one for the other, and boric and sodium oxides one for the other. The other two were substitutions of these 2 groups. Test specimens were rods drawn from each enamel which were annealed and were furnace cooled to below critical temperatures. The rods were then selected according to least variation of their diameter. Tests made included determinations of Young's modulus of elasticity, tensile strength and modulus of rupture. An increase in boric oxide from 13% to 19% with a corresponding reduction in Na oxide from 17% to 11% in a typical case, resulted in slight increase in modulus of rupture and extensibility together with a decrease in scatter of results on modulus of rupture. This property is considered important because the smaller the scatter the less liability of failure to occur below the reported strength.
WB (8f)

Cement-Lined Metal Pipe Fittings. Satisfactory Method for Irregular Shapes. *Commonwealth Engineer,* Vol. 22, Jan. 1, 1935, page 189. Describes a method of lining pipe fittings with cement particularly adapted to those of irregular shape. The method developed by E. F. T. Splatt of the Metropolitan Water Works, Melbourne, makes use of a non-inflatable, flexible rubber core so shaped that an annular space exists between core and fitting into which the cement is poured and left to set. The rubber molds can be withdrawn 24 hours after pouring. The internal surface is as smooth and even as the internal surface of a pipe centrifugally cement-lined. WH (8f)

Rust Protecting Coating of the Ship Elevator Niederfinow (Der Rostschutzanstrich des Schiffsheberwerkes Niederfinow). *Aluminium,* Vol. 17, Mar. 1935, page 152. In order to prevent the destruction of the rust-preventive oil-paint by the ultraviolet rays of sunlight, a pigment of mica and Al powder was added. The high reflectivity of Al for short-wave light prevents the oil binder from becoming brittle. 80-90% of the ultraviolet rays are reflected. Ha (8f)

Tarnish Proof Silver Coating (Anlaufbeständige Silberschichten). K. Assmann. *Chemiker-Zeitung,* Vol. 59, Mar. 13, 1935, page 217. The Ag or Ag plated articles are dipped for 3 to 6 min. in a solution of 100 g./l. of $K_2Cr_2O_7$ or $Na_2Cr_2O_7$ at room temperature. More dilute solutions can be used at higher temperatures, up to 100° C. A longer immersion is then required. This treatment prevents tarnishing of the Ag without changing the color and is better than lacquer. CEM (8f)

Paints for Water Tank Interiors. H. N. Bassett. *Railway Engineer,* Vol. 55, Jan. 1935, pages 405-406. Galvanized Fe is not suitable for water reservoirs. Waters vary greatly in corrosive properties, particularly rain water in industrial districts, surface water in moorland, or chalk and limestone areas and demands an intelligent selection of paints for coating Fe and steel tanks. Tests were carried out by the Egyptian State Railways on 64 non-metallic coatings. The results indicated only 1 satisfactory coating, a Pb chromate priming coat mixed with a specially flexible vehicle (to avoid cracking on temperature changes) followed by a coating of Al varnish. The tests were exhaustive and the samples were immersed in baths of condensate for 30 days partly at elevated temperatures. Red lead alone is not entirely satisfactory for water containing chlorides and chromate is required in addition. Weathering of steel tanks is very important for removing the mill scale which process is accelerated by brushing down with a solution of salammoniac which however requires careful washing and drying. American experiences on water tank coatings showed the best results for a chromate priming coat with 2 finishing coats of synthetic gum varnish. 4 other satisfactory paints consisted of Al powder in an elastic waterproof synthetic resin vehicle thinned down to working consistency with mineral spirits. Red lead in 3 coats ranked third with respect to the kind of water stored. WH (8f)

9. TESTING

9a. Inspection & Defects, including X-Ray Inspection

C. S. BARRETT, SECTION EDITOR

Cause of Flakes in Steel (Die Entstehungsursache der Flocken im Stahl). H. Bennek, H. Schenck & H. Müller. *Stahl und Eisen,* Vol. 55, Mar. 21, 935, pages 321-331. A critical analysis of the conditions under which flakes arise led to the conclusion that they must result from the solution pressure produced by H in supersaturated solid solution. The addition of H to the melts produced flakes in experimental ingots. O and N did not have this effect. Thermal and transformational stresses merely favor the appearance of flakes. They are not the sole cause, however, and merely influence thir orientation and location. The harmful effect of H is not limited to steels known to be particularly susceptible to flakes; the effect is present in other alloys as well and presumably in all steels. The familiar methods of avoiding the danger of flakes, either reduce the H content of the molten steel (as by the use of cold pouring and a mold wash low in H), or favor diffusion of H in the forging. This diffusion results during slow cooling, heating and long annealing before forging, etc. SE (9a)

Causes of Flakes in Steel (Die Entstehungsbedingungen der Flocken im Stahl). E. Houdremont & H. Korschan. *Stahl und Eisen,* Vol. 55, Mar. 14, 1935, pages 297-304. Flakes are described as shatter cracks arising after hot-working and not following the grain boundaries. In the literature, flakes are held to arise from stresses due to non-uniform cooling after forging or to transformational stresses, or to strains resulting from such defects as segregation, impurities and occluded gases. To clarify this situation, the conditions for the appearance of flakes were studied. The method of melting affects the susceptibility to flake; crucible steel and acid open-hearth and induction furnace steel are less susceptible than basic O.H. and electric steel. Susceptibility increases with size of ingot, teeming temperature, and speed of teeming; mold washes containing H also increase the susceptibility to flake. The bottom of the ingot is less susceptible than the top. Slow cooling and increased amounts of reduction in forging aid in obviating flakes. A most important observation was that the occurrence of flakes in forgings depended on the rate at which the forging cooled through the temperature range of about 200° C.; i.e., flakes occurred only on rapid cooling through this low temperature even if slowly cooled at higher temperatures. This indicated that deformational and transformation stresses as well as occluded gases were not the sole cause of flakes. SE (9a)

Method of Inspecting Gray Iron Castings (Modalita di Collando della Ghisa grigia in Getti). A. Steccanella. *Industria Meccanica,* Vol. 17, Mar. 1935, pages 191-193. The various methods to determine properties of castings are reviewed and standardization tendencies in Italy discussed. Specimens taken directly from the casting (cast on) are considered preferable to separately cast specimens from the same melt. Ha (9a)

Shrinking Wheel Tires. C. C. Downie. *Railway Engineer,* Vol. 56, Jan. 1935, pages 414-415. When tires become loosened from the wheel rims, microscopic examination usually revealed particles embedded between the wheel and tire originating from the coke fire. The later method of heating should be abandoned in favor of gas heating. Micro-structural examination of tires heated in a coke fire disclosed a slight absorption of C. WH (9a)

Dynamic Strength of Machine Parts Affected by Quality of Surface. A. V. DeForest. *Iron Age,* Vol. 135, Feb. 21, 1935, pages 19-22. From a paper read before the Society of Automotive Engineers at Detroit. Discusses the influence of seams, grinding checks and other surface imperfections in machine parts subject to dynamic stress. VSP (9a)

Welding and X-Raying the Boulder Dam Penstock. *Engineering News-Record,* Vol. 113, Nov. 15, pages 628-630. Fabrication of 45,000 tons of penstock steel is half completed and excellent results are reported for both the welding and X-ray inspection procedures. The procedure in making the radiograph is as follows: (1) The weld is laid off in 30" lengths. (2) The X-ray machine is brought into position, and the shielded cone of rays is directed toward the portion of the weld to be examined. (3) A film holder is placed on the inside of the pipe exactly opposite the cone from the X-ray tube. (4) An exposure of the proper length is made. Weld defects are divided into 4 classes: (1) Slag inclusions, (2) porosity, (3) incomplete fusion, and (4) shrinkage cracks. CBJ (9a)

The Protection of Radium Workers. Herbert Isenburger. *Metals & Alloys,* Vol. 6, Apr. 1935, pages 100, 105. Discusses protective methods in radium and X-ray work and gives a table of values of thickness of lead protection required for various conditions. WLC (9a)

The New Method for the Detection of the Internal Strain of Solids by Radiograph. Shinsuke Tanaka & Chujiro Matano. *Journal of the Society of Mechanical Engineers,* Japan, Vol. 37, Dec. 1934, pages 860-863. In Japanese. See *Metals & Alloys,* Vol. 6, Mar. 1935, page MA 110. Kz (9a)

Internal Stresses in Metals (Inwendige spanningen in metalen). A. E. van Arkel & W. G. Burgers. *Polytechnisch Weekblad,* Vol. 28, Aug. 16, 1934, pages 513-517; Aug. 23, 1934, pages 529-531; Aug. 30, 1934, pages 547-548. Considers the principles of the Laue, Schiebold-Polanyi and Debye-Scherrer-Hull method. Powder photograms of Ta_2C, ThO_2 and Th are presented. The utilization of X-rays for determining internal stresses in metallic materials is discussed, emphasizing the difficulties involved. The mechanism of plastic deformation and strain hardening and the subsequent changes of X-ray photographs are taken up. The phenomena occurring on annealing of worked metals at rising temperatures is discussed with reference to recent papers of a more fundamental nature. WH (9a)

9b. Physical & Mechanical Testing

W. A. TUCKER, SECTION EDITOR

Impact and Static Tensile Properties of Bolts. Herbert L. Whittemore, George W. Nusbaum & Edgar O. Seaquist. *Bureau of Standards Journal of Research,* Vol. 14, Feb. 1935, pages 139-187. The properties of bolts under impact tensile loading and also under static tensile loading were investigated. 360 specimens were tested, representing all possible combinations of 5 different materials, Cr-Ni steel, cold-rolled steel, Monel metal, bronze, and brass. 4 different bolt diameters were selected, ⅜", ½", ⅝" and ¾". 3 different forms of screw threads were used, U. S. Standard, SAE, and Dardelet. The bolts of different diameters were geometrically similar, the length between the head and the bearing face of the nut being 5 times the diameter, the thread extending inward from the face of the nut one diameter. In all cases the impact work for the bolts with U.S.S. threads was less than for bolts of the same size and material with SAE threads. Except for the brass bolts and those cold-rolled steel bolts which showed brittle failures, the impact work for bolts with SAE threads was approximately the same as for bolts of the same size and material having U. S. S. threads. Similar relations were observed for the static work and the maximum static load. For bolts of the same size and having the same threads the bolt efficiencies were approximately the same for all of the materials. WAT (9b)

New Machine for Measuring Hardness of Metals (Nouvelle machine pour l'essai de dureté des métaux). R. Guillery. *Revue de Métallurgie,* Vol. 32, Feb. 1935, pages 49-53. Mechanical features of a hardness measuring machine using the penetration principle and a Brinell ball which does not require the resetting of the dial after the first load application. JDG (9b)

A 2750 Kilogram Tensile Testing Machine for Small Test Bars (Machine de traction de 2.750 kg. pour barrettes reduites). R. Guillery. *Revue de Métallurgie,* Vol. 32, Feb. 1935, pages 58-60. Mechanical features of a testing machine suitable for small specimens. JDG (9b)

Comparative Tests on Steels with Uneven Hardness Fields (Jämförande provningar på stål med olika härdfält). Axel Lundgren. *Jernkontorets Annaler,* Vol. 119, Feb. 1935, pages 54-98. Because of the time consumed in mechanical tests, hardness tests are more desirable for rapid control of furnace charges for tool steels. For this purpose a sample is hammered or rolled to a plate of 2.5 to 4 mm. thickness. To eliminate differences between separate charges, normalizing under standardized conditions is necessary. The test piece is then cut down to 1.5 mm. thickness and hardened. A hardening temperature of 770° C. is recommended, followed by annealing at 200° C. and final cooling in air at 60° C. for 1 hour, and then to room temperature. Care should be taken to avoid contamination with lead during heating. Impact tests may be made with pendulum hammers of 0.5 kg. weight, but, with thicker and wider test pieces, larger weights may be desirable. HCD (9b)

Determination of Surface Hardness and Modulus of Elasticity with Rolland Pendulum Method (Meten van de oppervlakte-hardheid en van de elasticiteitsmodulus volgens de slingermethode van Prof. le Rolland). *Polytechnisch Weekblad,* Vol. 28, Aug. 30, 1934, pages 346-347. Underlying principles of and test results gained on the new testing machine designed by Rolland at the Institute Polytechnique de l'Ouest, France. WH (9b)

The Notched Bar Impact Test. A Discussion of the Machines and Methods. J. H. Lavery. *Commonwealth Engineer,* Vol. 22, Dec. 1, 1934, pages 139-147. The disadvantages and defects of the notched bar impact testing machines according to Charpy, Amsler, Izod, Frémont and Guillery and attempts to improve the technique and apparatus of the test are disclosed critically. Stress is laid on the theory of Ludwik, that the strength of a material is determined by 2 characteristics, viz. the resistance to slipping and the resistance to separation. In each of the present impact testing machines are certain sources of error, the chief of which is the varying loss of energy through transference to "earth" due to the reflection of stresses through the swinging stiff arm. This missing quantity depends on the time of fracture (1/1000-4/1000 sec.) or striking velocity. The 2 principal velocities with which stress is propagated through steel are of the order 17,000 and 10,500 ft./sec. A new testing machine developed at Oxford University is described which will abolish this source of error and which employs a less complicated method of loading the specimen. In this machine, both anvil and striker are slung on flexible suspension wires like a ballistic pendulum so that they swing without rotation. A close estimate of the energy used in fracturing the specimen is obtainable by measuring the swings of both anvil and striker. A 4 point method of loading the specimen is employed to reduce the complexity of stress distribution. Finally the author discusses the mechanism of failure under the impact test and refers to the application of the method to testing of welds. Izod values were found to be about 4% higher than the values of the ballistic machine, this quantity representing the energy lost to earth. WH (9b)

The Overstraining of Mild Steel. J. Muir. *Journal Royal Technical College,* Vol. 3, 1935, pages 372-384. Experiments are described in which a Hounsfield Tensometer was used to test, in tension, small specimens cut transversely to the axis of large steel bars previously overstrained in tension by a 100-ton tension machine. No yield points were obtained witn the transverse tests but only gradual departure from Hooke's Law from about the original yield point stress. This, and the nature of the fractures obtained with the transverse tests, are explained by regarding mild steel overstrained by tension to consist of a mixture of overstrained material and material in its original elastic condition. JWD (9b)

Estimating the Ultimate Strength of Materials. Victor Tatarinoff. *Heat Treating & Forging*, Vol. 21, Apr. 1935, pages 185-187. Results of tests relating to stresses other than tensile must be utilized with caution by the designer. Gives 2 examples showing deviations in strength that may be obtained. Torsion tests were made on Si-Mn steel approaching S.A.E. steel 9260 in composition. Specimens of different shapes and size were used in the as received and oil quenched condition. Ultimate strength in torsion was estimated from the torsional stress formula for twisting moments affecting failure of specimens. Results indicate that equation is inapplicable to short specimens of rectangular or flat steel and that a correction factor should be introduced. Presents graph for obtaining values of factor for different ratios of length of specimen to greater dimension of rectangle. Values of ultimate strength calculated from the fundamental formula should be divided by the factor. Using results of tests by Bureau of Standards on welded steel tubes and of other tests on larger seamless steel tubes, shows that bursting strength, as calculated by formula generally used, should be corrected for reaction forces arising at in fixtures, when short pieces are tested. Presents formula comprising all elements affecting resistance of tube walls to internal pressure, and graphs to facilitate its practical application. MS (9b)

A New Method of Investigating Performance of Bearing Metals. J. R. Connelly. *Transactions American Society of Mechanical Engineers*, Vol. 57, Jan. 1935, pages 35-39. A new method of reproducing wear under service conditions and giving variations of rate of wear with unit pressure is described. It consists in using a specimen of bearing metal with one side machined to a plane surface and a steel cylinder rotating in a bath of lubricant. A constant force holds the specimen with its plane side tangent to the cylinder. The mathematical relationship of the varying contact area and the variation of unit of pressure is derived and the application of the method explained. Ha (9b)

An Experimental Investigation of Cracking in Mild Steel Plates and Welded Seams. E. G. Coker & P. B. Haigh. *Institution of Naval Architects*, Advance Copy, Apr. 12, 1935, 11 pages. Tests carried out on "notched-plate" test pieces show that the stress reached in the metal at the bottom of the notch before plastic strain produces Lüders lines in mild steel, may be exceedingly high, and that much lower stresses, approximating in value to the lower yield point, are more uniformly distributed across the section behind the notch, when yield becomes general under greater loads. In ductile samples, with or without welds, fracture starts at or near the bottom of the notch under complex stresses, and in less ductile stresses, the gradual progress of the fracture is interrupted by sudden cracking, even when the rate of straining is low. Mild steel shows greater ductility when torn across, than along the direction of rolling, and certain electric welds as much ductility as mild steel torn across the direction of rolling. JWD (9b)

On the Plasticity of Crystals. Pol Duwez. *Physical Review*, Vol. 47, Mar. 1935, pages 494-501. A theory is given for the purpose of establishing a mathematical relation between the stress and the strain in a crystal when plastically deformed. The existence of a "secondary structure" in crystals is adopted as a basic hypothesis. The assumption that gliding in crystals takes place between the blocks of the secondary structure is the starting point. The final result which is the stress strain curve of a crystal, is an exponential law containing 3 constants torsional modulus, elastic limit, and maximum applied stress. The experiments were made on a Cu crystal. WAT (9b)

Mechanical Testing of Welded Joints; Bending Test (Mechanische Prüfung von Schweissverbindungen; Faltversuch, Biegeversuch). Matting. *Zwanglose Mitteilungen des Fachausschusses für Schweisstechnik*, No. 26, Apr. 1935, pages 7-8. The bending test gives an approximate and sufficiently reliable indication as to the deformability of welded joints; a mathematical relation with the deformations in tensile test has not so far been established. Dimensions of specimen, method of testing, and other supplementary tests as required by the German regulations are described. Ha (9b)

On the Yield Points of Mild Steel Beams Under Uniform Bending. Fujio Nakanishi, Masaharu Jtô & Kikuo Kitamura. *Aeronautical Research Institute*, Tokyo, Vol. 8, Mar. 1934, pages 274-289. In English. When mild steel beams of a cross-section asymmetrical about the neutral axes are bent, there are two yield points. Equations from which these yield points can be calculated are discussed. Kz (9b)

Resilience Tests—International Standardization of the Test-piece and Other Tests (Prove di resilienza—Unificazione internazionale della provetta ed altre indagini). A. Steccanella. *La Metallurgia Italiana*, Vol. 27, Feb. 1935, pages 81-108. Previous work on the comparison of resilience tests with test-pieces having 2, 3, and 5 mm. grooves has been extended, a large number of types of steels having been tested. Results confirm the previous conclusion that the 2 mm. groove as used in Italy, gives the most consistent results. Attempts to correlate the results with tests using the other sizes of grooves were not successful, the variation being too great. AWC (9b)

Autographic Thermal Expansion Apparatus. Wilmer Souder, Peter Hidnert & James Fulton Fox. *Bureau of Standards Journal of Research*, Vol. 13, Oct. 1934, pages 497-517. An autographic thermal expansion apparatus improved and constructed by the Bureau of Standards, the methods used in its calibration, and its precision as compared with the Bureau's precision equipment are described. WAT (9b)

Can the Influence of Plate Thickness Be Eliminated in Tests with the Erichsen Apparatus (Kan plåttjocklekens inflytande elimineasfrån resultatet vid provning med Erichsens djuppressningsapparat?) A. von Vegesack. *Jernkontorets Annaler*, Vol. 118, Dec. 1934, pages 553-591. The test determines the depth to which a ball of standard size must be pressed into a metal sheet over a standard hole before fracture occurs. The relation between d and d_{n1}, the depths respectively for plates of zero and given finite thicknesses, is given by the formula

$$d = d_{n1} \sqrt[4]{t}/1.0743$$

where t is the thickness of the plate in mm. The constant holds for the standard apparatus having a radius of 13.5 mm., but the formula holds in general for other radii, and the constants may be determined by a series of tests. In the testing of a large range of thicknesses it is recommended that a set of standards which are overlappingly calibrated be provided. HCD (9b)

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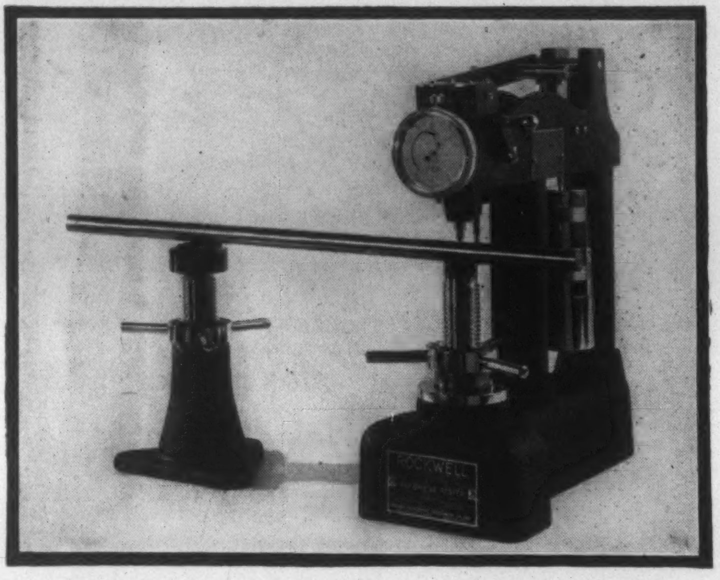

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9c. Fatigue Testing

H. F. MOORE, SECTION EDITOR

The abstracts appearing under this heading are prepared in cooperation with the A.S.T.M. Research Committee on Fatigue of Metals.

Atmospheric Action in Fatigue. H. J. GOUGH & D. G. SOPWITH. *Engineering*, Vol. 139, Mar. 15, 1935, page 290. Abstract of a paper "Some Further Experiments on Atmospheric Action in Fatigue." See *Metals & Alloys*, Vol. 6, Feb. 1935, page MA 67. VSP (9c)

Understressing and Overstressing on Iron and Steel. J. B. KOMMERS. *Engineering News-Record*, Vol. 114, Apr. 18, 1935, pages 550-551. Reports fatigue tests under reversed flexure made at the University of Wisconsin. The R. R. Moore rotating-beam machine was used. Repeated cycles of stress below the endurance limit of the virgin metal raised that limit. If the understress was "stepped up" in increments the strengthening effect may be greatly increased. The effect of cycles of stress higher than the endurance limit of the virgin material depended on how many cycles were applied. The application of a slight overstress for 20,000 cycles actually increased the endurance limit for some metals tested, while the application of the same stress for a much larger number of cycles lowered the endurance limit. Experiments showed that for some metals it was possible to overstress for a number of cycles sufficient to lower the endurance limit, and then to "cure" this damage by subsequent cycles of understress. Theory is put forward that when a metal is damaged by overstress, but not to the point beyond which it cannot be restored to virgin fatigue strength by understressing, an actual crack has not been formed. Kommers work seems to be in line with and an extension of French's "damage line" studies (see *Metals & Alloys*, Vol. 4, Nov. 1933, page 170.) HFM (9c)

Strength of Welds Under Impact Endurance Loads (Weerstand van lasschen tegen vermoeiingsschokbelastingen). P. SCHOENMAKER. *Polytechnisch Weekblad*, Vol. 28, Oct. 11, 1934, pages 646-647. The Losenhausen fatigue impact tester was used to determine the number of blows withstood by samples of the German standard structural steel St 37. Test bars were turned out of heavy plates butt welded in 6 different ways. The weld section on the specimens was provided with a circumferential groove. The average number of impacts of 5 test bars each yielded the following results with respect to the different method of making the V seam: plain material, not welded: 6572, uncoated electrode: 576, thinly coated electrode: 1786, electrode provided with medium sized coating: 2248, ordinary filler rod material with thick coat: 3162, same, but tougher brand of steel: 4970, same, and very tough electrode material: 5698. Typical fractures are illustrated confirming the high quality weld secured by high-grade coated electrodes. The small number of blows for fracture would seem to indicate that the tests showed ductility of welds fully as much as fatigue strength. WH (9c)

Relation of Fatigue to Forging Design. W. S. BURN. *Heat Treating & Forging*, Vol. 21, Feb. 1935, pages 71-76. From a paper read before the North East Coast Institution of Engineers and Shipbuilders. See *Metals & Alloys*, Vol. 6, May 1935, page MA 200. MS (9c)

Damping Properties of Crankshaft Steels at Room Temperature and 120° C. (Die Dämpfungsfähigkeit von Kurbelwellenstählen im Kalten und warmen Zustand bei Anlieferung und im Dauerbetrieb). A. APPENRODT. *Mitteilungen des Wöhler-Instituts*, No. 24, 1935, 98 pages. A series of C Ni, Ni Cr, Ni Mo, Ni W, Ni Cr Mo and Ni Cr W steel specimens, many of them cut from large crankshafts, and ranging from 70,000 to 200,000 lbs./in.^{2} tensile strength was studied as to torsional damping properties. Torsional endurance tests were made, which, being carried out by the step-up method, are admittedly only rough approximations and tend to give high values because of strengthening by understressing. The damping properties were studied, at low intensities of loading on material as received, and after 1/20, 1/4, 1-1/4, 6-1/2, and 31-1/4 million cycles of repeated stress, both at 20° and, in suitably heated apparatus, at 120° C. Between damping tests, the specimens were run in an endurance machine, well below the endurance limit, up to the desired number of cycles, so as to represent different stages of service. The change in damping properties between the original condition and 1/20 million cycles is usually noticeable, thereafter it changes less often, becoming approximately constant at 6-1/2 million. In general, the damping ability increases with service in the very hard steels, and decreases in the soft ones. Some of the strongest steels, however, showed no appreciable change in damping at any stage of service or at either temperature. Slight differences in behavior were noted between 20° and 120° C., but when the damping curves at each temperature are assembled, the steels arrange themselves in the same order at either temperature, with the low-tensile steels showing high damping ability and the high-tensile ones, low damping. The experiments are recorded in great detail and give a good idea of the methods of making torsional damping tests. Partly on account of the hazy way in which the endurance properties were approximated, it is difficult to trace any connection between damping properties and endurance limit, and the author makes no effort to do so. 20 references. HWG (9c)

Degree of Fatigue and Recovery Therefrom of Carbon Steel Under Repeated Impact. FUMIO OSHIBA. *Society of Mechanical Engineers*, Japan, Vol. 37, July 1934, pages 436-443. See *Metals & Alloys*, Vol. 6, Apr. 1935, page MA 161. Kz (9c)

Recent Developments Regarding Welded Joints and the Effects of Fatigue. O. BONDY. *Welding Journal*, Vol. 32, Mar. 1935, pages 70-71. General review and discussion. WB (9c)

A Method for Determining Stresses in a Non-Rotating Propeller Blade Vibrating with a Natural Frequency. WALTER RAMBERG, PAUL S. BALLIF & MACK J. WEST. *Bureau of Standards Journal of Research*, Vol. 14, Feb. 1935, pages 189-201. Propeller failures in flight generally have the appearance of fatigue fractures. This points to resonant vibrations setting up excessive alternating stresses as a probable cause of failure. A method is described for measuring and calculating such alternating stresses for a nonrotating blade vibrating in resonance with an alternating torque applied to its shaft. A complete picture of the stress distribution was obtained by measuring the longitudinal and transverse strain amplitudes at various points, and calculating the stresses from these data, assuming a condition of plane stress at the surface of the blade. Stress distributions were obtained for a duralumin blade vibrating with its fundamental mode and also for the same blade vibrating with its second harmonic mode, with a node near the tip. The effect of restraint at the hub on frequency and on stress distribution was also investigated theoretically, and it was found that the degree of restraint at the hub affected the stress distribution very little, but that it had considerable effect on the natural frequency. It was noted that artificially produced fatigue failures in 8 nonrotating blades vibrating with their fundamental mode occurred in each case at a section where the stresses were within a few % of the maximum stress. WAT (9c)

Stress Analysis of Failure in Machine Parts. F. L. EVERETT. *Mechanical Engineering*, Vol. 57, Mar. 1935, pages 157-161. The reasons for a number of fatigue failures are discussed and composition, design and stresses in the fractured parts are described. Ha (9c)

9d. Magnetic Testing

L. REID, SECTION EDITOR

Magnetic Properties of Nickel Near the Curie Point (Propriétés Magnétiques du nickel à proximité du point de Curie). L. NÉEL. *Journal de Physique et le Radium*, Vol. 6, Jan. 1935, pages 27-34. **(Susceptibilité magnétique du nickel dans les champs faible au voisinage immédiat du point de Curie).** L. NÉEL. *Bulletins de la Société des Française de Physique*, No. 358, June 1, 1934, pages 120-121. An apparatus is described suited for the determination of magnetic susceptibilities in a field of 50-1000 gauss incorporating a device for adjusting and measuring the temperature with an improved degree of accuracy. Susceptibility measurements on 2 grades of Ni with 99.76% and 99.91% Ni near the Curie point in relation to temperature and magnetic field are reported. The Curie point of the 99.9.% Ni is 357.9° ± 0.3° C. EF (9d)

Magnetic Method of Testing Welded Joints. RENE LEONHARDT. *Electrical Engineer & Merchandiser of Australia*, Vol. 11, Dec. 15, 1934, pages 261-263. Testing of welded joints by tracing a magnetic field across them has been practiced for some time, but has suffered the disadvantage that rather unwieldly apparatus has been required. This has been overcome by the new method described. The testing apparatus has been so sensitized that the magnetic field set up by application of permanent magnets to the material to be tested will suffice. A small search coil, comparable in size and shape to an electric soldering iron, is placed across the joint, and the presence of any defect is indicated by a change of the tone of electrical vibration from the coil, as heard in a pair of headphones. This method detects faults, but does not permit the diagnosis of their nature. WH (9d)

9e. Spectrography

Interference Measurements in the Infrared Arc Spectrum of Iron. William F. Meggers. *Bureau of Standards Journal of Research,* Vol. 14, Jan. 1935, pages 33-40. Wave lengths of the stronger infrared radiations characteristic of integrated light from an Fe arc at atmospheric pressure are measured relatively to neon standards by the Fabry-Perot interferometer method. Values are given for 91 lines ranging from 7164.469 to 10216.351 A. Spectral term combinations indicate that most of these lines require relatively high excitation energies, which accounts for their character and properties. Difference between values from integrated arc light at atmospheric pressure and from the vacuum arc are interpreted as pressure- and Stark-effects. It is suggested that the international system of secondary standards of wave length can be extended into the infrared by using integrated light from an Fe arc at 1 atm. pressure. WAT (9e)

Quantitative Analysis of Light Alloys by Spectroscopy. Yu. A. Klyachko. *Light Metals,* Vol. 3, No. 1, 1935, pages 29-36. In Russian. Theoretical considerations precede experimental procedure. Analysis of duralumin is described. Condensed spark is struck between duralumin electrodes. After exposure of 20 seconds duralumin is replaced by Cu electrodes and several exposures on the same plate are made. As reference line is used Cu line 2492 which is matched with Al line 3050. Other homologous pairs can be used as reference lines. Mg and Mn contents determined analytically and spectroscopically check reasonably well. (9e)

A Projection Instrument for the Analysis of Spectrographic Plates. C. H. Eldin. *Journal of Scientific Instruments,* Vol. 11, Nov. 1934, pages 357-359. Design of instrument for examining spectrographic plates by projecting them on a white surface is given. Method of calibration described. Wave lengths can be read to an accuracy of ±1 A.U. in the range 2100-3000 A.U. RAW (9e)

First Spectrum of Tantalum. C. C. Kiess & E. Z. Stowell. *Bureau of Standards Journal of Research,* Vol. 12, Apr. 1934, pages 459-469. Wave lengths of more than 2100 lines emitted by the arc in air between electrodes of Ta have been measured in the spectral region from 10,300 A. U. in the infrared to 2,300 A. U. in the ultraviolet. These lines are characteristic of the spectrum emitted by neutral Ta atoms. Many of the lines are clearly complex and present the appearance of narrow rectangles. Several lines in the ultraviolet were observed as absorption lines in the spectrum of the underwater spark. The arc spectrum is always accompanied by an extension band spectrum, attributable to the oxide, which consists of bands shaded toward the red from inconspicuous heads. These heads have been measured. WAT (9e)

Preliminary List of Terms for the Arc Spectrum of Tantalum. C. C. Kiess & Harriet K. Kiess. *Bureau of Standards Journal of Research,* Vol. 11, Aug. 1933, pages 277-278. A preliminary list of Ta I terms, accounting for most of the strong arc lines is presented. The low ^4F and ^4P terms and the metastable ^6D and ^4D terms are identified with those to be expected theoretically from the electron configurations $5d^3 \cdot 6s^2$ and $5d^4 \cdot 6s$. WAT (9e)

The Spectrographic Analysis of Aluminium. D. M. Smith. *Journal Institute of Metals,* Vol. 56, Feb. 1935, pages 119-130 (Advance Copy No. 696). Ordinary photographic records of arc and spark spectra of graded series of standard alloys of Al with Cu, Fe, Mn, Si, and Ti were investigated from the point of view of establishing a satisfactory routine method of analysis. The spark gives a steadier and more reproducible source of light and, since adequate sensitivity of detection of the impurities usually found in Al is obtained, analytical tables were compiled for use with the spark method. For routine testing an auxiliary alloy of Al with 1% Ni is used for the auxiliary spectrum method, but increased accuracy could be obtained by direct comparison with suitably selected standard samples. The arc method is more sensitive for detection of traces of such impurities as Pb and Ga. 7 references. JLG (9e)

The Use of the Spectrograph in Metallurgical Analysis. D. M. Smith. *Analyst,* Vol. 60, Jan. 1935, pages 17-23. The technique, methods of analysis, and future developments are discussed. AHE (9e)

Contributions to the Methodology of Quantitative Spectral Analysis of Elements. Investigations on Sn+Pb (Beiträge zur Methodik der quantitativen Spektralanalyse der Elemente. Untersuchungen an Sn+Pb). Hans Schubert & Kurt Cruse. *Zeitschrift für physikalische Chemie,* Abt. A, Vol. 172, Feb. 1935, pages 143-155. Electrolytic preparation of Pb-free (<0.00057 at. % Pb) Sn. High-precision method for quantitative spectral-analytical determination of the Pb content of Sn-Pb alloys using a rotating logarithmical sector for measurement of the intensity of spectral lines. Table of standard Pb-line lengths as depending on the Pb content, from 0.00099 wt. % to 16.5 wt. % Pb. The intensity of the emitted light is not proportional to the number of Pb atoms present in the alloy. Detailed discussion of the methodological and theoretical sources of error of the described method. ORS (9e)

The Spectrographic Analysis of Some Alloys of Aluminum. Ernest H. S. van Someren. *Foundry Trade Journal,* Vol. 51, Nov. 15, 1934, pages 311-312. See *Metals & Alloys,* Vol. 6, Apr. 1935, page MA 163. CEJ (9e)

Instruments Used for Spectrum Analysis and Absorption Spectrophotometry. F. Twyman. *Analyst,* Vol. 60, Jan. 1935, pages 4-8. Descriptive. AHE (9e)

The Role of the Spectrograph and of Minor Elements in Die Castings. Thomas A. Wright. *Metals Technology,* Apr. 1935, *American Institute Mining & Metallurgical Engineers, Technical Publication* No. 614, 9 pages. The influence of impurities in die-casting alloys is discussed and the importance of purity control pointed out. Contamination is best avoided and all minor but important elements controlled within the allowable limits by spectrographic analyses. 9 references. JLG (9e)

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10. METALLOGRAPHY

J. S. MARSH, SECTION EDITOR

Review of Theoretical Metallurgy during 1934. Robert F. Mehl. *Metals Technology,* Jan. 1935, *American Institute Mining & Metallurgical Engineers, Technical Publication* No. 594, 18 pages. Bibliography of 382 references. Subjects considered are theories and states of aggregation, allotropy, growth and properties of metal crystals, deformation, recrystallization and grain size, crystal-structure data, structure of alloys, electron diffraction, transformation in alloys, age hardening, constitution of alloy systems, thermal properties and thermodynamics, diffusion, reaction with gases and corrosion, and electrical and magnetic properties. Findings of the different investigators are mentioned and definite references to the original papers and to reviews are given. JLG (10)

Rhodium-copper Alloys. O. E. Zvyagintzev & B. K. Brunovski. *Transactions Platinum Institute,* No. 12, 1935, pages 36-66. In Russian. Alloys with less than 60% Rh were melted in fireclay crucibles under borax in a cryptol furnace. With higher Rh they were melted in a high-frequency induction furnace. The weight of the melts was 40-60 g. Electrolytic Cu and Rh with 0.38% impurities were used. Annealing was effected in a resistance furnace. Specimens were kept at 750°-800° C. for 3 days immersed in molten borax. Quenching was done by throwing specimens in water after soaking for 20-30 minutes at 1100° C. Under 40% Rh, alloys could be etched with HNO_3 or aqua regia; above 70% Rh molten potassium pyrosulphate was used. Alloys oxidize very easily. It is possible to think that in high Cu alloys oxidation is intensified by the catalytic action of Rh. Cu mesh moistened with $RhCl_3$, heated and reduced absorbed O_2 remarkably well. Hardness curve of quenched alloys shows a continuous change passing through a maximum at 50 at. % Rh. Hardness of the annealed alloys generally follows the former but has a drop corresponding to the maximum of the former curve and a second drop around 75-85 at. % Rh. Maximum quenched hardness is 250 Brinell, annealed 200. These minima point to the possibility of CuRh and $CuRh_3$. Thermal analysis did not give accurate results on account of high oxidizing power of the alloys which is so great that even melting under slag did not prevent oxidation. Difficulties in determination of solidification temperatures permitted drawing only a tentative diagram, which is limited to 58 at. % Rh. Near 50 at. % Rh a transformation in the solid state at 1015° C. was noted. 12 photomicrographs show a polyhedral structure of alloys in α-phase range and a mixture of two solid phases. X-ray examination showed a continuous change in parameter up to 20 at. % Rh. Around this concentration the limit of solubility of Rh in Cu ends and 2 phases are observed. Up to 20 at. % Rh, the alloys have the face-centered lattice of Cu with a gradually increasing parameter, corresponding to α-phase. Between 90 and 100 at. % Rh, face-centered lattice of Rh is observed, β phase; in other compositions a mixture of both is seen. On annealing, alloys with a composition close to 50 at. % Rh undergo a transformation and are composed of pure α phase, with close to 75 at. % of pure β phase. The presence of supplementary lines on the photographs of the alloys corresponding to the composition Rh_2Cu_2 and Rh_3Cu together with other data show that in Rh-Cu system when the ratio of the components is 1:1 and 3:1 a transformation in solid state takes place with the formation of compounds. With the composition $RhCu_3$, there are indications of a partial transformation. The lattices of all alloys are close to the lattice of the β phase and are similar in their parameters. The alloy with 50 at. % Rh has a lattice composed of alternating layers of both compounds, but it remains cubic, no indications of tetragonal transformation have been observed. (10)

The System Praseodymium-gold. (Il sistema praseodimio oro). Armando Rossi & L. Mazza. *Gazzetta chimica italiana,* Vol. 64, Oct. 1934, pages 748-757. The Pr was free of rare earths and contained 0.5% impurities (chiefly Si and C; m.p. 950° C.) The Au was 99.9% pure. The 2 metals alloy with the evolution of considerable heat, with formation of 4 definite compounds: $AuPr_2$, m.p. 710°; AuPr, m.p. 1350°; Au_2Pr, m.p. 1210°, and Au_4Pr, m.p. 1200°. The mutual solubility in the solid state of Pr and Au is small and negligible from a practical standpoint. Prolonged annealing at 600° of alloys rich in Pr leads to the formation of a new cubic phase (face-centered), which superposes itself on the preexistent hexagonal form and which is probably β-Pr in solid solution with small proportions of Au and impurities. The sp. ht. of Pr (impure) between 20° and 100° is 0.0486 ± 0.0007. Sp. ht. determinations of the alloys show in each case an experimental value higher than the theoretical value for a mixture, with the greatest difference for the most difficult fusible AuPr. In alloys rich in Pr, Au and Pr can be separated by solution in dilute HCl, the Au precipitated with H_2S and determined gravimetrically. The solution is evaporated, dissolved in water, excess $H_2C_2O_4$ is added at the b.p., the precipitate is dissolved in dilute H_2SO_4 and titrated with $KMnO_4$. The hardness of the alloys increases rapidly with increase in the proportion of Pr, and reaches high values for the compounds AuPr and Au_4Pr. The phase diagram is described in detail. It contains 4 minima and 3 maxima from 0 to 100% Au. 19 photomicrographs. CCD (10)

The Iron-platinum Alloys. Curie Points and Magnetic Moments (Les alliages fer-platine. Points de Curie et moments magnétiques). F. Aallot. *Bulletins de la Société Française de Physique,* No. 360, July 1934, pages 146-147. Fe and Pt form a continuous series of solid solutions the transformations of which have not been established thoroughly. Curie points and atomic moments were determined for the entire system. Up to 3.7 at. % Pt, the alloys are reversible and exhibit a fixed Curie point, viz., that of Fe. Above 3.7 at. % Pt, the Fe-Pt alloys become the more irreversible the higher the Pt content. At 20 at. % Pt, the Curie point is 500° C. higher with rising temperatures than with falling ones. Above 20 at. % Pt, the Curie point drops below room temperature. Extrapolation of the transformation line hits the absolute zero point at 25 at. % Pt. The atomic moment of Fe-Pt alloys rises linearly with increasing Pt additions up to 12.5 at. % Pt and then drops back to its initial value in the same fashion at 23 at. % Pt. This phenomenon known with alloys comprising 2 ferromagnetic metals (Fe-Co, Fe-Ni, Fe-Mn) has thus been found for the first time on an alloy with only one ferromagnetic component. A superstructure of the Fe_7Pt type is predicted. Due to the spontaneous magnetization the α phase is stabilized in a temperature range where the γ phase should occur. EF (10)

Reactions in the Solid State, I—Initial Course of Subcritical Isothermal Diffusion Reactions in Austenite in an Alloy Steel. Howard A. Smith. *Metals Technology,* Feb. 1935, *American Institute Mining & Metallurgical Engineers, Technical Publication* No. 602, 20 pages. Initial stages in decomposition of austenite in a steel at the constant subcritical temperature of 450° C. were investigated. The steel contained 0.92% C and 6.48% Mn. It had been previously studied by Bain. Microscopic observations and measurements of dilation, electric conductivity, magnetic permeability, hardness, lattice parameter and monochromatic X-ray diffraction-line width were made throughout the course of reaction. Each type of measurement was found useful, and all, with some additional methods, were considered necessary for the study of the rearrangement proceeding within the solid previous to and during the precipitation of a new phase. Microscopic observations were most reliable for determining the volume percentage of the various phases present. As for numerous other solid solutions, an initial decrease in conductivity of the interstitial solid solution of C in γ Fe was observed. 40 references. JLG (10)

Electrochemical and X-ray Investigation of Solid Thallium Amalgams (Eine elektrochemische und röntgenographische Untersuchung von festen Thallium Amalgamen). Arne Ölander. *Zeitschrift für physikalische Chemie,* Abt. A, Vol. 171, Dec. 1934, pages 425-435. Supplementary dilatometric, potentiometric, and X-ray spectrographic determination of the Tl-Hg phase diagram. Pure β Tl melts at 303.5° C. and transforms into α Tl at 234° C. Both transformation temperatures decrease with increasing Hg content. The (binary) γ phase, unsaturated between 9.7% and 14.5% Hg at 20° C., is body-centered cubic (a = 3.819 A.U. at 10% Hg, a = 3.811 A.U. at 14% Hg) and melts incongruously at 198° C. The (binary) δ phase, unsaturated between about 69% and 80% Hg, is face-centered cubic (a = 4.664 A.U. at 71% Hg). Temperature coefficients of the electrode potential of homogeneous δ alloys indicate that the maximum stability of the δ phase does not occur at Tl_2Hg_5, the composition of the temperature maximum of the liquidus; nor at $TlHg_3$, as suggested by X-ray spectrographs; but, most likely, at $TlHg_2$, as in β brass. Dilatometric arrests observed by Roos in ternary Tl-Hg-Pb alloys with about 71% Hg and small Pb contents do not indicate an allotropic transformation of the binary δ phase, but refer to the ternary (δ-Pb) eutectic solidification. ORS (10)

Equilibrium Relations in the Copper Corner of the Ternary System Copper-tin-beryllium. Elbert S. Rowland & Clair Upthegrove. *Metals Technology,* Feb. 1935, *American Institute Mining & Metallurgical Engineers, Technical Publication* No. 613, 26 pages. Thermal analyses, X-ray determinations, and quenching experiments followed by microscopic examination were used in determining the diagram for Cu-rich alloys containing up to 1% Be and 32% Sn. Quasi-binary sections for 0.25, 0.50 and 1.0 weight % Be were first determined. Isothermal sections were then constructed from these constant-Be sections. Liquidus and solidus temperatures in the ternary system decrease with increasing Be content while the solid-phase boundaries in the quasi-binary sections shift to lower values of Sn as the Be increases. The size of the γ-phase field decreases markedly with decrease in temperature below 650° C., probably accounting for the precipitation-hardening characteristics of the alloys. A third phase persists over a large area, and tests indicated that this phase is the α phase of the Cu-Be system. 18 references. JLG (10)

Phase Diagram of Two Alkali Metals: Potassium-Rubidium Alloys (Diagrammes de Solidification des Alliages Formé par Deux Métaux Alcalins: Alliages Potassium-Rubidium). E. Rinck. *Comptes Rendus,* Vol. 200, Apr. 1, 1935, pages 1205-1206. Microscopic evidence indicates that K-Rb alloys form a complete series of solid solutions with a minimum corresponding to the composition KRb_2. FHC (10)

Iron and Nitrogen (Eisen und Stickstoff). A. Sieverts & G. Zapf. *Zeitschrift für physikalische Chemie,* Abt. A, Vol. 172, Mar. 1935, pages 314-315. The solubility limit of N_2 in (Armco) Fe at 760 mm. Hg is:

Phase	α		γ			δ			melt
Temperature, °C.	750	890	900	1300	1390	1420	1450	1500	1540
N_2, mg./100 g. Fe	0.4	2.0	25	22	21	10	11	12	31

The reaction is strictly reversible at 1400° C. Upon solidification at 760 mm. Hg the N_2-saturated Fe melt releases about 17 mg.N_2/100 g. Fe. ORS (10)

Ni-Mn System (Über das System Nickel-Mangan), Siegfried Valentiner & Gotthold Becker. *Zeitschrift für Physik,* Vol. 93, Feb. 26, 1935, pages 795-803. The Ni-Mn system was studied by X-ray, magnetic, and electrical measurements. In an alloy of 25 atomic % Mn, the existence of Ni_3Mn is said to be the cause of strong paramagnetism. At 50 atomic % Mn, the lack of ferromagnetism is probably due to the tetragonal lattice of the intermetallic compound Ni-Mn. FHC (10)

Study of Al-Mg Alloys in Solid Solution Range (Contribution a l'Étude des Alliages Formés par la Solution Solide Aluminium-Magnésium). G. Chaudron & R. Dandres. *Comptes Rendus,* Vol. 200, Apr. 8, 1935, pages 1324-1326. Both electrolytically refined Al and sublimed Mg had purity of 99.99%. After treatment at 450° C. followed by air cooling to make alloys homogeneous, mechanical properties were studied as a function of % Mg. The addition of 1% Zn or Cd does not change the mechanical properties of the Al-Mg solid solution, which may be explained on the basis that Mg, Zn and Cd crystallize in the hexagonal system. Alloys were also treated to precipitate Al_3Mg_2, which may create an e.m.f. of 0.2 volts with the result of local corrosion. FHC (10)

Constitutional Diagram of Silver-indium System (Das Zustandsdiagramm des Systems Silber-Indium). Friedrich Weibke & Hans Eggers. *Zeitschrift für anorganische und allgemeine Chemie,* Vol. 222, Mar. 8, 1935, pages 145-160. The Ag-In diagram is shown as well as freezing and transformation-point data. Debye X-ray intensity measurements for confirmation of the structure of compounds are given. Lattice constants of the α phase and δ phase were determined for 0-21 atomic % In for slowly cooled and quenched material. Microstructures are shown WB (10)

Linear Thermal Expansion and Transformation Phenomena of Some Low-carbon Iron-Chromium Alloys. J. B. Austin & R. H. H. Pierce, Jr. *Metals Technology,* Jan. 1935, *American Institute Mining & Metallurgical Engineers Technical Publication* No. 589, 18 pages. Alloys containing from 3.25 to 10.58% Cr were studied. They were prepared by Rohn in a vacuum furnace and contained as much as 0.030% C, 0.023% Si, and 0.057% N. Expansion was determined in a vacuum dilatometer previously described and the rate of heating and cooling was usually 3.0 to 3.5° per min. Transformation temperatures were also determined with a magnetic balance. The coefficient of expansion decreased slightly as Cr increased. The instantaneous coefficient at 50° C. was 11,5 for the alloy with 3.25% Cr and 10.9 for one with 9.02% Cr. Determination of transformation temperatures proved that there was a minimum in the loop of the austenitic field. The significance of this minimum is discussed. The dilatometer readings show that the rate of transformation of alloys on cooling is of the same type as the rate for Ni and Mn steels previously described by Bain. 17 references. JLG (10)

Dependence of Rate of Transformation of Austenite on Temperature. J. B. Austin. *Metals Technology,* Jan. 1935, *American Institute Mining & Metallurgical Engineers Technical Publication* No. 590, 9 pages. The rate of transformation is influenced by the driving force, which increases as the temperature decreases below the critical point, and by the "viscosity," which tends to slow down the rate as the temperature decreases. 7 references. JLG (10)

X-ray Studies on the Nickel-chromium System. Eric R. Jette, V. H. Nordstrom, Bernard Queneau & Frank Foote. *Transactions American Institute of Mining & Metallurgical Engineers,* Vol. 111, 1934, pages 361-373. Includes discussion. See *Metals & Alloys,* Vol. 5, Apr. 1934, page MA 153. (10)

Correlation of Equilibrium Relations in Binary Aluminum Alloys of High Purity. William L. Fink & H. R. Freche. *Transactions American Institute of Mining & Metallurgical Engineers,* Vol. 111, 1934, pages 304-318. Includes discussion. See *Metals & Alloys,* Vol. 6, Jan. 1935, page MA 26. (10)

Type Metal Alloys. Frances D. Weaver (Mrs. Harold Heywood). *Journal Institute of Metals,* Vol. 56, Jan. 1935, pages 9-41. (Advance Copy No. 691). Pb-base Sb-Sn-Pb alloys were investigated by means of thermal analysis and microexamination. The liquidus surface for alloys containing up to 24% Sb and 14% Sn was constructed. The general lines of the phase diagram put forward by Iwasé and Aoki were confirmed. The existence of a true ternary eutectic in the Pb-base corner was confirmed, but with the composition 12% Sb, 4% Sn, and 84% Pb solidifying at 239° C. The ternary peritectic point of Loebe and others is shown to be the eutectic point of a pseudo-binary system of Pb and the compound SbSn. A method of etching was developed which distinguishes between the α and β Sb-Sn phases, whether present as primary constituents or in the eutectic. Microstructures obtained by different rates of cooling were studied. Hardness tests were also made. 16 references. JLG (10)

Studies Upon the Widmanstätten Structure, VI—Iron-rich Alloys of Iron and Nitrogen and of Iron and Phosphorus. Robert F. Mehl, Charles S. Barrett & H. S. Jerabek. *Transactions American Institute of Mining & Metallurgical Engineers,* Vol. 113, 1934, pages 211-229. Includes discussion. See *Metals & Alloys,* Vol. 5, June 1934, page MA 282. (10)

Studies Upon the Widmanstätten Structure, V—The Gamma-alpha Transformation in Pure Iron. Robert F. Mehl & Dana W. Smith. *Transactions American Institute of Mining & Metallurgical Engineers,* Vol. 113, 1934, pages 203-210. Includes discussion. See *Metals & Alloys,* Vol. 5, May 1934, page MA 214. (10)

Influence of a Grain Boundary on the Deformation of a Single Crystal of Zinc. Richard F. Miller. *Transactions American Institute of Mining & Metallurgical Engineers,* Vol. 111, 1934, pages 135-145. Includes discussion. See *Metals & Alloys,* Vol. 6, Jan. 1935, page MA 28. (10)

Effect of Titanium on Iron and Steel. A review of published information. E. Morgan. *Bulletin British Cast Iron & Steel Research Association,* Vol. 4, Jan. 1935, pages 82-85. Review and bibliography. WB (10)

Observing Formation of Martensite in Certain Alloy Steels at Low Temperatures. O. A. Knight & Helmut Müller-Stock. *Transactions American Institute of Mining & Metallurgical Engineers,* Vol. 113, 1934, pages 230-238. Includes discussion. See *Metals & Alloys,* Vol. 5, June 1934, page MA 279. (10)

The Lithium-magnesium Equilibrium Diagram. Otto H. Henry & Hugo V. Cordiano. *Transactions American Institute of Mining & Metallurgical Engineers,* Vol. 111, 1934, pages 319-332. Includes discussion. See *Metals & Alloys,* Vol. 5, June 1934, page MA 279. (10)

An X-ray Study of the Diffusion of Chromium into Iron. Laurence C. Hicks. *Transactions American Institute of Mining & Metallurgical Engineers,* Vol. 113, 1934, pages 163-178. Includes discussion. See *Metals & Alloys,* Vol. 5, May 1934, page MA 213. (10)

Intermetallic Solid Solutions. Eric R. Jette. *Transactions American Institute of Mining & Metallurgical Engineers,* Vol. 111, 1934, pages 75-93. Includes discussion. See *Metals & Alloys,* Vol. 5, Dec. 1934, page MA 580. (10)

An X-ray Study of the Gold-iron Alloys. Eric R. Jette, Willard L. Bruner & Frank Foote. *Transactions American Institute of Mining & Metallurgical Engineers,* Vol. 111, 1934, pages 354-360. Includes discussion. See *Metals & Alloys,* Vol. 5, Apr. 1934, page MA 154. (10)

Structure and Origin of the Copper-Cuprous Oxide Eutectic. L. W. Eastwood. *Transactions American Institute of Mining & Metallurgical Engineers,* Vol. 111, 1934, pages 181-195. Includes discussion. See *Metals & Alloys,* Vol. 5, Apr. 1934, page MA 154. (10)

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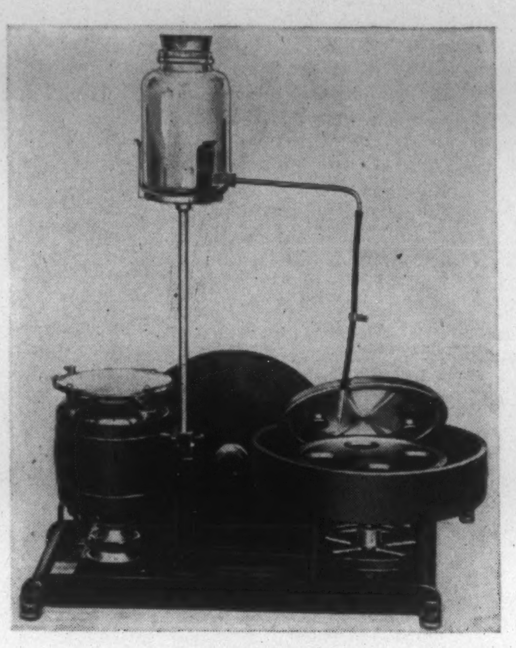

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First Communication on X-ray Investigations of Transformation Processes. On an Application of the Weissenberg X-ray Goniometer for Recording Transformation Processes (Erste Mitteilung über röntgenographische Untersuchungen von Umwandlungsvorgängen. Über eine Anwendung des Weissenbergschen Röntgengoniometers zur Registrierung von Umwandlungsvorgängen). J. Böhm & P. Feldmann. *Zeitschrift für physikalische Chemie,* Abt. B, Vol. 27, Dec. 1934, pages 425-430. Detailed description of an X-ray goniometer with a heating device for continuous recording of changes of the crystal structure upon phase transformation or recrystallization. The film carriage may be propelled continuously at a constant rate or discontinuously at equal time intervals during exposure. Thus, consecutive states are recorded by contiguous X-ray spectrographs. The method is even better suited for recording electronic spectra. Continuously and discontinuously recorded X-ray spectrographs of recrystallizing platinum black are used to illustrate the method. ORS (10)

Laue Diagrams of Deformed Crystals. W. F. Berg. *Zeitschrift für Kristallographie, Kristallgeometrie, Kristallphysik, Kristallchemie,* Vol. 83, Dec. 1934, pages 587-593. In English. From a point of view which considers the 3 Laue conditions as 2 conditions defining cross-grating spectra due to a cross-grating nearly normal to the incident beam, and the third condition defining a cone, the following facts are plausibly explained: Laue spots of a deformed crystal are elongated in a radial direction if the diagram is taken by transmitting X-rays. The Laue spots of a crystal deformed in a general way are smeared out in all directions in a diagram taken by reflecting X-rays. The Laue spots of a crystal the deformation of which consists of bending around an axis normal to the incident beam are elongated in a direction perpendicular to the axis of deformation. A reflected Laue diagram is comparatively insensitive to errors in setting the crystal. EF (10)

Studies upon the Widmanstätten Structure, VII—The Copper-silver System. Charles S. Barrett, Hermann F. Kaiser & Robert F. Mehl. *Metals Technology,* Jan. 1935, *American Institute Mining & Metallurgical Engineers Technical Publication* No. 595, 19 pages. A Widmanstätten figure may be formed in Cu-rich Cu-Ag alloys by extremely slow cooling. The Ag-rich precipitate takes the form of plates parallel to {100} planes of the Cu-rich matrix. The precipitate in the Ag-rich alloys is usually a pearlitic arrangement of irregular plates. By extremely slow cooling a Widmanstätten figure may be developed in which the Cu-rich plates are parallel to {111} planes of the matrix. X-ray data proved that there is an identical orientation of matrix and precipitate in both Cu-rich and Ag-rich alloys, even when the outward form of the precipitate in the latter is pearlitic in appearance. Previous theories for the formation of Widmanstätten structure fail to explain these results. It is suggested that the usual mechanism is not operative and that a less-frequent mechanism is involved. The nature of this mechanism is not known. Numerous grains in Ag-rich alloys, when quenched and annealed, recrystallize into a new set of orientations related to the orientation of the original grain. The new orientation may be derived from the old by rotating in 2 directions of 42° ± 5° about [100], [010], and [001] directions of the original lattice as axes. The recrystallization appears to be associated with the discontinuous change of matrix lattice during precipitation. JLG (10)

X-ray Investigation of Some Complex Catalyzers (Röntgenuntersuchung einiger Mischkatalysatoren). Gustav Wagner, Georg-Maria Schwab & Rudolf Staeger. *Zeitschrift für physikalische Chemie,* Abt. B, Vol. 27, Dec. 1934, pages 439-451. The catalytic effect of the mixtures: $CuO+ZnO$, $CuO+MgO$, $CuO+Cr_2O_3$, $CuO+Al_2O_3$, and $Cu+Ni$ is coordinated with their crystal structure as determined by X-rays. X-ray interference lines of the mixtures Ni_2Cu and Ni_3Cu, produced by joint reduction of the oxides of both metals, appear as wide bands whose maximum intensity occurs almost at the positions of the pure Ni interference lines and which extend almost to the positions of the pure Cu interference lines (which do not appear as such). This interference pattern indicates that the so produced Ni-Cu solid solutions are inhomogeneous. These interference bands indicating the presence of crystal lattices of continuously varying dimensions should be distinguished from the symmetrically widened interference lines indicating the presence of very fine crystallites in the specimen. ORS (10)

The Influence of Diffusion Elements Upon the Alpha-gamma Inversion of Iron. W. D. Jones. *Iron & Steel Industry,* Vol. 8, Oct. 1934, page 21. Abstract of paper presented at the Iron & Steel Institute Meeting in Belgium. See *Metals & Alloys,* Vol. 5, Dec. 1934, page MA 580. CEJ (10)

Paramagnetism and Diamagnetism in Alloys Exhibiting a Pseudo-Curie Point (Le paramagnetisme croissant superpose au diamagnetisme dans les alliages à faux Point de Curie). R. Forrer & A. Serres. *Bulletins de la Societe Francaise de Physique,* No. 358, June 1934, page 121. See "A New Magnetic Phenomenon," *Metals & Alloys,* Vol. 5, Oct. 1934, page MA 490. EF (10)

On the Space Lattices of Berthollides. A. Glazunov. *Collection of Czechoslovak Chemical Communications,* Vol. 7, Feb. 1935, pages 77-83. In English. Intermetallic compounds which do not obey Proust's Law are given a special name "Berthollides," defined by the inequality

$$R_{A_n B_n} \neq \int (R_A, R_B)$$

i.e., the product of mutual action of the original substances, the physical and chemical properties of the product being in no functional relation to those of the original substances. Classical examples of berthollides are the hexagonal phases Mg-Ag, Ag-Cd, Au-Cd, Ag-Sn, Ag-Sb, Cu-Si, Cu-Au. Berthollides have space lattices of their own, in which the atoms of the components are distributed statistically. "Daltonides" are compounds with space lattices in which the atoms of the components are arranged regularly according to a definite law. GTM (10)

Quantitative Space Lattice Analysis by X-rays (Quantitative Raumgitteranalyse mit Röntgenstrahlen). Richard Glocker. *Forschungen & Fortschritte,* Vol. 10, Nov. 10, 1934, page 395. Discusses the various factors which affect the intensity of X-ray reflection lines and which are obstructive to a quantitative analysis. Calls attention to the possibility of practically eliminating the absorption of X-rays in the powder sample itself by mixing the latter with a multiple quantity of cork dust. The preparation of the powder must be carried out carefully since stresses induced frustrate a quantitative evaluation of the reflection lines. EF (10)

Crystallographic Uniformity of Lineage Structure in Copper Single Crystals. Alden B. Greninger. *Metals Technology,* Jan. 1935, *American Institute Mining & Metallurgical Engineers Technical Publication* No. 596, 9 pages. Interpretation of fine structure within individual spots on unsymmetrical back-reflection Laue photographs of Cu single crystals indicated that such crystals possess a crystallographically uniform lineage structure (mosaic structure). Predominant relations between neighboring lineages were a common direction [110] and a boundary plane {111}. Less frequent relations were a common direction [100] and a boundary plane {110} or {100}. JLG (10)

Interferences Gained from Galena Lattice Planes by Means of Cathode Rays (Flächengitterinterferenzen bei Durchstrahlung von Bleiglanz mit Kathodenstrahlen). Sten von Friesen. *Arkiv för Matematik, Astronomi och Fysik,* Vol. 24 B, No. 8, 1934, 4 pages. In German. Thompson's method (*Proceedings of the Royal Society,* Vol. A 133, 1931, page 1) of producing interferences by electron rays reflected on etched single crystals has been applied to etched surfaces of PbS. It is pointed out that the lattice planes perpendicular to the incident electron rays (20-26 kvolts) are chiefly responsible for the reflections. EF (10)

Theory and Use of the Metallurgical Polarization Microscope. Russell W. Dayton. *Metals Technology,* Jan. 1935, *American Institute Mining & Metallurgical Engineers Technical Publication* No. 593, 32 pages. Previous work on the study of opaque minerals and metals with the polarization microscope is reviewed. Theories of the behavior of polarized light are described and the polarization metallurgical microscope described. Suggestions for improvements of available microscopes are given. A study of a number of metals and inclusions is described. Anisotropy could be detected in many instances where it should occur, the effects being less marked than for transparent substances. Sometimes anisotropy should be present but was not apparent; owing either to the smallness of the anisotropy or to the presence of surface films. Surface films were observed on Zn. Anisotropy due to strain could not be detected. The instrument was found to be useful in the study of inclusions. It can detect either surface anisotropy or transparency of inclusions. The formation of the black cross in glassy inclusions, previously described, is explained. 17 references. JLG (10)

On the Existence of a Transformation of Exactly Second Order (Über die Existenz einer Umwandlung von genau zweiter Ordnung). U. Dehlinger. *Zeitschrift für physikalische Chemie,* Abt. B, Vol. 28, Feb. 1935, pages 112-118. Thermodynamic characteristics of transformations of metallic phases involving changes of the distribution of atoms in the crystal lattice from an ordered to an unordered one. The transformation in AuCu and $AuCu_3$ is of the first order, in Fe_3Al most likely of the second order. ORS (10)

Questionnaire on Dendrites, Monocrystalline State, Grain of Metals and the Mechanism of its Growth (Enquête sur les dendrites, sur l'état monocrystallin, sur le grain des métaux et sur le mécanisme de sa croissance). Léon Dlougatch. *Revue de Métallurgie,* Vol. 32, Jan. 1935, pages 23-31; Feb. 1935, pages 85-99. Questions on the above subjects were submitted to 14 metallurgists of England, Germany, France, Japan and Sweden and to 10 in Russia. Opinions agreed in general, though some individual points were stressed by different investigators. JDG (10)

Heusler Alloys (Über Heuslersche Legierungen). S. Valentiner & G. Becker. *Zeitschrift für Physik,* Vol. 93, Feb. 14, 1935, pages 629-633. Electric resistance and magnetization studies were made on an alloy of 25% Mn, 25% Al, and 50% Cu. The Curie point of this alloy occurs at 330° C. Aging takes place at 300° C. with precipitation of Cu_2MnAl, which the authors claim is the ferromagnetic constituent. FHC (10)

The Linnaeite Group of Cobalt-nickel-iron-copper Sulfides. W. A. Tarr. *American Mineralogist,* Vol. 20, Feb. 1935, pages 69-80. A study of the chemical composition of the best analyses available for the various members of the linnaeite group has furnished evidence that all members of the group should be represented by the general formula $R''R_2'''S_4$. The 4 elements Co, Ni, Fe, and Cu are isomorphous but Cu only is divalent. The atomic radii of the 4 metals are so nearly identical that such isomorphism is easily possible. X-ray studies of all the members (except violarite) proved that they have the spinel structure type. It appears doubtful whether further X-ray investigations would contribute any more information regarding the structures of the group. EF (10)

Formation of Solid Solution and Lattice Constants of Ag-Cu Alloys (Mischkristallbildung und Gitterkonstanten bei Silber-Kupfer-Legierungen). P. Wiest. *Zeitschrift für Physik,* Vol. 94, Mar. 19, 1935, pages 176-183. Author plots variation of lattice constant against % Ag to show "lattice constant isotherms." In contrast to earlier work, the slopes of these lines are identical for cast single crystal and for recrystallized polycrystalline alloy. FHC (10)

New Method for Measuring Lattice Constants (Une méthode nouvelle pour mesurer les constantes cristallines). V. Kunzl & J. Köppel. *Journal de Physique et le Radium,* Vol. 5, Apr. 1934, pages 145-151. The authors introduce a new method for the determination of lattice constants and check measurements on SiO_2 against results obtained with the widely used method of Siegbahn. The advantages of the authors' new method are stressed. EF (10)

Cellular Distortions in Cast Irons (Distorsioni reticolari nelle ghise). V. Montoro. *La Metallurgia Italiana,* Vol. 27, Feb. 1935, pages 109-110. Samples of cast iron, water quenched, show distortion in crystalline structure up to 0.78% in the martensite, and none in the cementite. AWC (10)

Suggestions on a Simple Reproduction and Evaluation Method of Debye Photographs (Vorschläge zur einfachen Reproduktion und Beurteilung von Debye-Aufnahmen). Karl Meisel. *Zeitschrift für Kristallographie, Kristallgeometrie, Kristallphysik, Kristallchemie,* Vol. 90, Jan. 1935, pages 92-95. Paper before the Autumn Meeting of the Nordwestdeutsche Chemiedozenten, Hanover, Sept. 22, 1934, criticizes the expensive and time-consuming evaluation of X-ray films by photometric means and the unreliable reproduction by a hand-made drawing. A new photographic reproduction method is introduced. An image of the original film is projected through a band-like or wedge-shaped aperture placed at some distance from and perpendicular to the film onto photographic paper or a screen. The dimensions of the copying apparatus are given and an X-ray film reproduced in 6 ways is shown. These photographs, which straighten the curved powder-reflection lines, demonstrate that the original lines are reproduced truly in regard to position and intensity. EF (10)

Metallography of Aluminum Bronzes (La metallografia microscopico dei bronzi d'alluminio). C. Panseri. *Alluminio,* Vol. 4, Jan.-Feb. 1935, pages 3-50. An extensive summary, including 305 micrographs and 58 references. The difficulty of etching Al bronze samples is overcome by the use of a dilute solution of HNO_3 and HF (50 cc. HF, 100 cc. HNO_3, 750 cc. H_2O.) A preliminary study of the effect of addition of V to Al bronzes is made; the most noticeable effect is to render the α elements in the bronzes extremely minute. A new component appears in the V-Al system, which may be AlV_2 or AlV_3 as suggested by Czako and Corson. AWC (10)

Some Effects of Copper in Malleable Iron. Cyril Stanley Smith & Earl W. Palmer. *Metals Technology,* Feb. 1935, *American Institute Mining & Metallurgical Engineers, Technical Publication* No. 603, 21 pages. By dilatometric and other methods the addition of Cu was found to accelerate both first-stage and second-stage graphitization of white cast iron. The effect is roughly proportional to the amount of Cu added and 1% Cu reduced graphitization time by about 50%, although this is affected by rate of heating and other factors. The addition of 1 to 1.5% Cu increases yield point about 10,000 lb./in.^{2} and a further increase of from 10,000 to 15,000 lb./in^2 can be brought about by a precipitation-hardening treatment. The latter consists in heating to just below the critical point, air cooling and reheating to about 500° C. The increase in tensile and yield strength is accompanied by some loss in ductility. JLG (10)

Theory of Real Crystals (Zur Theorie der Realkristalle). Adolf Smekal. *Zeitschrift für Kristallographie, Kristallgeometrie, Kristallchemie, Kristallphysik,* Vol. 89, Oct. 1934, Sonderheft "Ideal- & Realkristall," pages 386-399. Discusses the subject under the following heads: (1) Theory of real crystals and general structurally sensitive properties; (2) Shortcomings of previous hypothesis; (3) Real crystal imperfections in the crystal lattice; (4) Experimental results on the physical properties of crystals (plasticity, elasticity, cohesion). EF (10)

On the Higher Series of the X-ray Spectra. Manne Siegbahn & Torsten Magnusson. *Arkiv för Matematik, Astronomi och Fysik,* Vol. 24B, No. 6, 1934, 5 pages. In English. The K-, L- and M- series of the X-ray spectra have been extensively investigated by the crystal grating methods, whereas the higher series (N, O), which are to be expected with the heavier metals, have not been detectable with these methods. The experimenters utilized the ultra-soft X-ray region and measured a sequence of elements some series of which must be ascribed to the transitions at the higher atomic levels (N, O, P). The photographs gained on Tl, Pb, Bi and Th and on the N series of the elements from Cs to Eu are reproduced. EF (10)

The O-Series of the X-ray Spectra. Manne Siegbahn & Torsten Magnusson. *Arkiv för Matematik, Astronomi och Fysik,* Vol. 24B, No. 7, 1934, 2 pages. In English. Proof is furnished that the experimenters succeeded in obtaining and identifying reflection lines of Th which belong to the O series. (See also abstract above.) EF (10)

Ferromagnetic Transformation and Catalytic Activity (Ferromagnetische Umwandlung und katalytische Aktivität). J. ARVID HEDVALL, R. HEDIN & O. PERSSON. *Zeitschrift für physikalische Chemie,* Abt. B, Vol. 27, Dec. 1934, pages 196-208. The catalytic effect of Ni on the reaction $N_2O = N_2 + O$ changes discontinuously at the temperature of the magnetic transformation (Curie point) of Ni, confirming the validity of Hedvall's rule also for state changes due to changes of the magnetic moments of valence electrons from antiparallel to parallel orientation not involving changes of lattice symmetry. The magnetic transformation of c.p. Ni was found to occur within the temperature interval from 355° to 365° C., the steepest drop of magnetization occurring between 358° and 361° C.; that of commercial Ni with 99.1% Ni, 0.4% Fe, 0.2% Mn, 0.1% Cu, 0.1% Mg, 0.03% Si—from 335° to 344° C. and between 337° and 340° C., respectively. ORS (10)

Contribution to the Knowledge of the Substitutability of Zinc by Magnesium and vice versa. I. On the Intersolubility of Mg_3Sb_2 and Zn_3Sb_2 and the Structure of the Solid Solution (Zur Kenntnis der Ersetzbarkeit von Zink und Magnesium und umgekehrt. I. Über die Mischbarkeit von Mg_3Sb_2 und Zn_3Sb_2 und die Struktur der Mischkristalle). KARL LÖHBERG. *Zeitschrift für physikalische Chemie,* Abt. B, Vol. 27, Dec. 1934, pages 381-403. The crystal lattice of the Mg_3Sb_2-Zn_3Sb_2 solid solution is of either of the 3 types: $C\frac{1}{3_1}$, $D\frac{2}{3}$, or $D\frac{3}{3_d}$. Positions $[|000|]$ are occupied by Mg atoms, positions $\left[\left|\frac{1}{3}\,\frac{2}{3}\,u\right|\left|\frac{2}{3}\,\frac{1}{3}\,\bar{u}\right|\right]$ $(u = 0.231)$—by Sb atoms, positions $\left[\left|\frac{1}{3}\,\frac{2}{3}\,v\right|\left|\frac{2}{3}\,\frac{1}{3}\,\bar{v}\right|\right]$ $(v = 0.641)$—by Mg and Zn atoms in statistical distribution. The distances between the atoms and the decrease of the lattice constant with increasing Zn content suggest that the atoms of the component substances in this acid solution are not ionized. ORS (10)

Determination of the Number of Crystals Within the Range of from 1-100 μ by Means of Debye-Scherrer Photographs (Bestimmung der Kornzahl im Bereiche von 1 bis 100 μ auf Grund der Debye-Scherrer Aufnahmen). H. S. SCHDANOW. *Zeitschrift für Kristallographie, Kristallogeometrie, Kristallphysik, Kristallchemie,* Vol. 90, Jan. 1935, pages 82-91. It is shown that under certain conditions, the number of interference spots on Debye-Scherrer reflection rings may be utilized for determining the number of crystals in the sample under test. The new method is applied to a study of the recrystallization of brass and Cu. With respect to the latter, the following number of interference spots "n" on the (111) reflection line were counted in relationship to annealing temperature t:

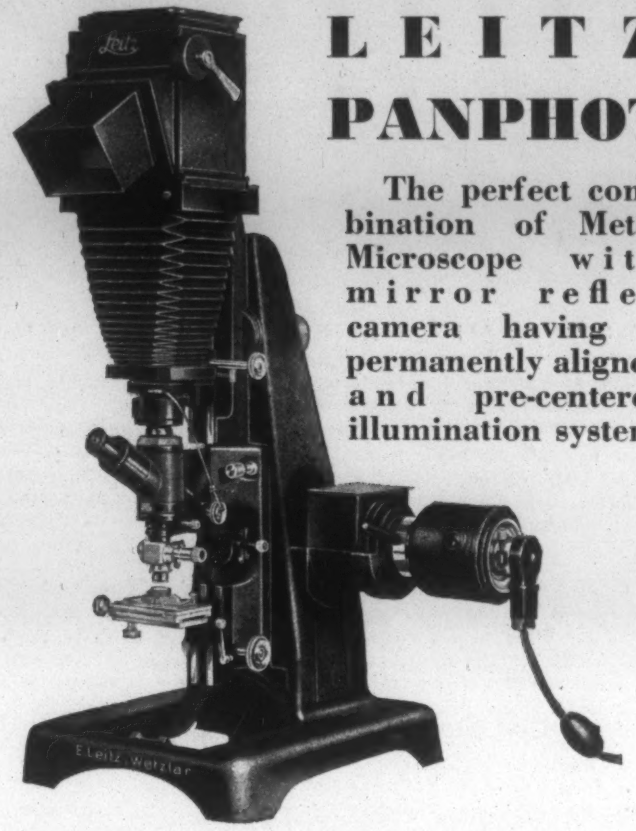
t°C.	325	350	375	400	425	450
n_{111}	160	450	480	1450	2200	1800

(The amount of cold rolling is not stated and the annealing times were only 10 seconds.) The author stresses that there are 2 distinct stages during recrystallization characterized by the relatively slow increase of the number of crystals between 300° and 375° C. and by the drastic change at about 400° C. A formula is derived correlating the number of interference spots on a powder reflection line to the number of crystals/unit volume. A graphical method is developed for determining a proportionality factor introduced by the dimensions of the Debye camera used. EF (10)

Mechanism of Plastic Deformation. II. The Effect of Plastic Deformation on Phase Changes (Über den Mechanismus der plastischen Deformation. II. Über den Einfluss der plastischen Deformation auf die Phasenumwandlungen). A. W. STEPANOW. *Physikalische Zeitschrift der Sowjetunion,* Vol. 5, No. 5, 1934, pages 706-713. In a previous paper (See *Physikalische Zeitschrift der Sowjetunion,* Vol. 4, 1934, page 609) the hypothesis was advanced that plastic deformation results in "amorphization" of the lattice regions adjacent to the slip planes. This paper considers various factors which affect transitory and permannent property changes in a crystal due to plastic deformation. The conditions of these intermediary layers are affected by (1) temperature, (2) polymorphous transitions, (3) various physical properties such as diffusion and expansion coefficient, lattice forces, constants of thermal conductivity, (4) effects to which the crystals are submitted during plastic deformation (5) volume changes (additional stresses) during lattice changes, (6) direction of heat dissipation and orientation of neighboring crystal grains (nucleus formation). Most of the factors considered are correlated to deformation speed and temperature. The author advocates that phase changes as the consequence of plastic deformation do not represent exceptions but are the rule. EF (10)

Transformations of β Brass and Related Phenomena (Über die Umwandlung des β-Messings und verwandte Erscheinungen). HELMUTH V. STEINWEHR. *Forschungen & Fortschritte,* Vol. 10, Nov. 20, 1934, pages 407-408. Discusses the transformation phenomena of the "third order" according to Justi & von Laue (See *Sitzungsberichte der Preussischen Akademie der Wissenschaften,* 1934, page 1) whereby a gradual transition takes place over a temperature range. Regarding the β brass transformation, it is still doubtful whether we are dealing with an isomorphous mixture or an intermetallic compound in which both constituents occur in varying proportions over a small concentration range. Describes at length determination of heat change at elevated temperatures in a specially constructed apparatus which yielded 3.0 kcal./g. for β brass between 475° and 430° C. Thermoelectric, dilatometric, and electrical resistance measurements proved the absence of hysteresis effects since the same type of curves was obtained on cooling and heating. Unreported experiments on ferromagnetic materials (Fe, Co, Ni) show that elements can also display a similar behavior in gradual transitions. EF (10)

The Deep Etching of Steel. *Metal Cleaning & Finishing,* Vol. 6, Dec. 1934, page 616. Four formulas are given for etching solutions: (1) HCl 34 fl. oz., H_2O 34 fl. oz., $HgNO_3$ 2 oz., powdered glue 16 oz. Heat. Cool before using. (2) HCl 3 parts, HNO_3 1 part. Take 3 parts of this mixed acid and 1 part of water for rapid etching. (3) HNO_3 32 oz., HCl 3 oz., denatured alcohol 6 oz., water 96 oz. (4) Equal parts HNO_3 and HCl full strength, or diluted with 25% water. GBH (10)



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Equilibrium Relations in Aluminum-nickel Alloys of High Purity. WILLIAM L. FINK & L. A. WILLEY. *Transactions American Institute of Mining & Metallurgical Engineers,* Vol. 111, 1934, pages 293-303. Includes discussion. See *Metals & Alloys,* Vol. 5, Dec. 1934, page MA 580. (10)

Crystal Orientations Developed by Progressive Cold Rolling of an Alloyed Zinc. M. L. FULLER & GERALD EDMUNDS. *Transactions American Institute of Mining & Metallurgical Engineers,* Vol. 111, 1934, pages 146-157. Includes discussion. See *Metals & Alloys,* Vol. 5, Apr. 1934, page MA 153. (10)

A Camera for Electron Diffraction. J. A. DARBYSHIRE & E. R. COOPER. *Journal Scientific Instruments,* Vol. 12, Jan. 1935, pages 10-17. Complete details are given of a camera designed to enable a wide range of experiments on electron diffraction to be carried out. The apparatus is suitable both for reflection and transmission and also any general type of rotation of the specimen examined. RAW (10)

Theoretically interesting Aspects of High Pressure Phenomena. P. W. BRIDGMAN. *Reviews of Modern Physics,* Vol. 7, Jan. 1935, pages 1-33. A review of the author's recent work on the effect of high pressures on atomic changes, 2-phase equilibrium in the melting curve, and polymorphic transitions in solids; also on the electric and thermal conductivity of metals. Compressibility of single crystals was determined. Includes discussion of the theory of changes produced and a revision of the author's previous prediction of the probable effect of still higher pressures. Bibliography is appended. WB (10)

Classification of Alpha Iron-nitrogen and Alpha Iron-carbon as Age-hardening Alloys. JOHN L. BURNS. *Transactions American Institute of Mining & Metallurgical Engineers,* Vol. 113, 1934, pages 239-261. Includes discussion. See *Metals & Alloys,* Vol. 5, Dec. 1934, page MA 580. (10)

The High-zinc Region of the Copper-zinc Phase Equilibrium Diagram. E. A. ANDERSON, M. L. FULLER, R. L. WILCOX & J. L. RODDA. *Transactions American Institute of Mining & Metallurgical Engineers,* Vol. 111, 1934, pages 264-292. See *Metals & Alloys,* Vol. 5, Dec. 1934, page MA 578. (10)

The Cobalt-molybdenum System. W. P. SYKES & HOWARD F. GRAFF. *Transactions American Society for Metals,* Vol. 23, Mar. 1935, pages 249-285. Paper read and discussed at A.S.M. Convention, 1934. See *Metals & Alloys,* Vol. 6, Jan. 1935, page MA 30. WLC (10)

The Constitution of Iron-rich Fe-Al-C Alloys. F. R. MORRAL. *Iron & Steel Industry,* Vol. 8, Oct. 1934, page 21. Abstract of paper presented at the Iron & Steel Institute Meeting in Belgium. See *Metals & Alloys,* Vol. 5, Dec. 1934, page MA 579. CEJ (10)

The Decomposition of Martensite. GUNNAR HÄGG. *Iron & Steel Industry,* Vol. 8, Oct. 1934, pages 21-22. Abstract of paper presented at the Iron & Steel Institute Meeting in Belgium. See *Metals & Alloys,* Vol. 5, Dec. 1934, page MA 580. CEJ (10)

11. PROPERTIES OF METALS AND ALLOYS

Copper Steels to Resist Corrosion. *The Copper Development Association, Publication* No. 4, 9 pages. **The Behavior of Copper on Exposure to the Elements,** *publication* No. 7, 4 pages. **Brasses,** *publication* No. 6, 2nd edition, 47 pages. These booklets published by the Copper Development Association give concise information on the subjects indicated. The one on Brasses is in the form of an engineering handbook, giving the engineering properties in tables and curves. This is to be followed by others in the same series dealing with applications of brass and special alloys of copper for high strength and high temperature services. HWG (11)

Chemical Elements and Natural Atomic Forms According to the Status of Isotope Investigations. Report of Investigations from the End of 1933 to the End of 1934 (Die Chemischen Elemente und natürlichen Atomarten nach dem Stande der Isotopen-Forschung. Bericht über die Arbeiten von Ende 1933 bis Ende 1934). Otto Hahn. *Berichte der deutschen chemischen Gesellschaft,* Vol. 68, Jan. 9, 1935, pages 1-15. A review of isotope investigations during 1934. Only work on natural isotopes, not those artificially produced, is included. Tables of all known isotopes with the mass no., individual atomic wt., % occurrence, and other data are given. 35 references. CEM (11)

Problem of Skin Conductivity of Metals (Zur Frage der Oberflächenleitfähigkeit von Metallen). A. W. Maue. *Die Naturwissenschaften,* Vol. 22, Sept. 21, 1934, page 648. Study of the contribution of the surface waves to the electric conductivity of metals. The establishment of the equilibrium of this skin effect takes place independently of the space wave equilibrium. A calculation carried through in analogy to the Block theory leads to a skin conductivity which is of the same order as the "space" conductivity of a mono-atomic metal layer. EF (11)

Elastic Modulus (Le module d'élastité). Léon Guillet, Jr. *Revue de Métallurgie,* Vol. 32, Feb. 1935, pages 61-68. Summary of published data. 22 references. JDG (11)

Report on Strengthening Effects of Bolt Threads. Harry B. Pulsifer. *Steel,* Vol. 96, Feb. 11, 1935, pages 30-34. Compares physical properties of normal bolts and of test-bars turned down to root diam. from stems. Tabulates results of 50 comparisons, using 13 materials, 10 thread sizes, and variations of treatment. Bolt sizes ranged from ¼" to ¾" diam. Threads were both coarse and fine. Strengths varied from 45,000 lbs./in.^{2} to 240,000 lbs./in.^{2} Discusses materials and properties. MS (11)

11a. Non-Ferrous

A. J. PHILLIPS, SECTION EDITOR

Some Notes on Phosphor-Bronze. R. C. Stockton. *Metal Industry,* London, Vol. 45, Oct. 5, 1934, pages 315-317. The important factors which control satisfactory production are raw materials, melting practice, type of mold and disposition of runners, conductivity of the mold, casting temperature, contraction cavities and method of casting. Author indicates that this alloy is used chiefly for bearings or power transmission and points out that the composition is varied according to the conditions under which it is to be used. Each of the previously mentioned major factors which influence production is discussed. Under raw materials, the impurities present and the influence of some of them are considered. Rapid melting is recommended. The necessity of rapid cooling is emphasized. The factors to be considered in the selection of the correct casting temperature are indicated. Casting under pressure and the addition of certain other elements are suggested as means of reducing contraction cavities. Possible variations in test-bars cut from castings and the influence of casting temperature on "cast-on" test-bars are considered. A method of obtaining test-bars from chill bars is included. HBG (11a)

Y Series. Aluminium Alloys. Eiichiro Itami. *Suiyokwai-shi,* Vol. 8, Mar. 1934, pages 343-366; June 1934, pages 519-532; Oct. 1934, pages 585-615. The author studied the influence of chemical composition upon the mechanical properties of sand cast Al-alloys containing Cu, Ni and Mg, i.e., Y-alloy composition, and also the influence of heat treatment upon the age-hardening of these alloys. The mechanical properties of forged alloys containing Cu 1-8%, Ni 1-3% and Mg 0.5-2% were systematically examined and the alloys containing Cu 3-5%, Ni 1-2% and Mg 1-1.5% showed the best results on tensile testing. The alloy Cu 3%, Ni 1-2% and Mg 1-1.5% is recommended for forging. The effect of heat-treatment on these alloys is discussed in detail. HN (11a)

The Property of Permanent Set in Certain Non-Ferrous Alloys. J. E. Hurst. *Metal Industry,* London, Vol. 45, Oct. 26, 1934, pages 387-391. This is a study of the importance of the elastic behavior of materials in their effect upon press or shrink fits. The permanent set properties of certain non-ferrous alloys were studied comparatively by means of extensions of the testing procedure outlined in B.S.I. Specification 5004 and Aircraft Material Specification No. 4K6. A ring-form specimen is machined from the sample in accordance with the Specification. The gapped ring is used for the determination of the EN value (a form of modulus of elasticity), and of a permanent set value. In the initial stages of test there seems to be a relationship between Brinell hardness and the permanent set value which appears to decrease with increasing hardness. Tables are included showing the data obtained on Cu-Al, Monel metal, light Al alloys, Al-Si and Al-Cu-Zn alloys. The results show that the Al-Si and Cu alloys take up a very substantial permanent set at low stress values and that the Al-Cu-Zn undergoes less permanent set than the others and up to stress values of approx. 4 tons/in.^{2} is somewhat similar to cast iron. HBG (11a)

Aluminum Alloys—The Interdependence of Casting Design and Treatment of the Material. W. C. Devereux. *Machinery,* London, Vol. 46, Apr. 4, 1935, pages 7-11. Abstract of the first part of a paper read before the Scottish local section of the Institute of Metals. The importance of the correct temperature of metal and mold, method of feeding and chilling castings of Al are detailed for production of fine-grained, equi-axed structure. Heat-treatment at high temperature and aging for increased strength is advisable only for small castings of heat-treatable alloys. In large castings heat-treatment is inadvisable as it sets up excessive internal stresses. The effect of heat-treatment on ultimate strength, elongation and hardness, of chill and sand castings is shown in tabular form. An impact testing machine for the cast material is shown and described and results obtained for various British Al alloys are tabulated and shown in curves. The effect of fluxing is shown to increase grain size in addition to the beneficial elimination of gas and "speckiness." The author cautions against the production of a weak, coarse-grained structure by overfluxing. WB (11a)

Alloys of Magnesium. Part II. The Mechanical Properties of Some Wrought Magnesium Alloys. W. E. Prytherch. *Journal Institute of Metals,* Vol. 56, Jan. 1935, pages 59-76 (Advance Copy No. 693). Mg alloys were melted under a flux and cast in a chalked iron mold filled with SO_2. Various methods of rolling were studied and the influence of rolling temperature and heat treatment on the mechanical properties determined. The alloys studied were those of Mg with Zn, Cd, Al, Zn-Cd, Zn-Cd-Al, and Cd-Al. All were very sensitive to rolling conditions. X-ray studies indicated preferred orientation of the basal plane parallel to the direction of rolling and preferred orientation was not removed by heating to 500° C. for 30 min. In certain alloys work hardening accompanied by improved mechanical properties could be produced by rolling in certain temperature ranges. Zn had little influence on strength but improved ductility. Cd-Mg alloys were soft and ductile and probably suitable for extrusion. Al increases both strength and ductility of Mg, the optimum amount being between 4 and 7%. Cd-Zn-Mg alloys are moderately strong and very ductile. They will probably be useful for sheets that are to be hot stamped. The addition of Al to Cd-Mg alloys increase strength; the addition of Cd to Al-Mg alloys increases ductility and in certain instances malleability. Cd-Zn-Al-Mg alloys have valuable properties at room temperature but are weak above 300° C. Cold rolling up to 10% improves mechanical properties of certain alloys, and they can then be further improved by heating to 100° C. for 4 hrs. An alloy of 8% Cd and 8% Al treated in this manner had the properties of a high-strength Al alloy. JLG (11a)

Monel Metal (Le Métal Monel). L. Guillet. *Cuivre et Laiton,* Vol. 8, Mar. 30, 1935, pages 133-134. Composition, physical and mechanical properties are briefly reviewed. Ha (11a)

Paramagnetic Constants of Platinum at Low Temperatures (Paramagnétisme constant du platine aux basses températures). G. Foëx & Spielrein. *Bulletin de la Société Française de Physique,* No. 360, July 1934, page 146. Former experiments of Collet & Foëx on the susceptibility of Pt at low temperatures are checked. The paramagnetism of 4 different brands of Pt proved to be independent of temperature and cannot be connected with ferro-magnetic contaminations. The Curie rule is re-established with the presence of 1% Fe or Co. EF (11a)

Wrought Copper-Nickel-Aluminum Alloys. D. K. Crampton & H. P. Croft. *Metals & Alloys,* Vol. 6, Apr. 1935, pages 79-84. 7 references. Previous work on alloys up to 40% Ni and 10% Al is discussed. Data reported show Ni and Al both reduce the forgeability, Al more than Ni. Study of the range Ni 4-16% and Al 0.5-4.0% shows alloys of Ni 4.76, Al 1.32% and Ni 9.21% and Al 1.33% to give best response to age hardening with highest properties. 9.21% Ni alloy shows somewhat higher impact values except when aged in range 800-1200° F. where it shows marked embrittlement while this temperature range gives the highest impact values for the 4.76% Ni alloy. Properties of a work hardening alloy of 4% Al, 4% Ni are discussed and the various physical properties of this alloy and an age hardening alloy of 7.5% Ni, 1.5% Al are tabulated. WLC (11a)

The Exact Measurement of the Specific Heats of Solid Substances at Higher Temperatures. The Specific Heats of Vanadium, Niobium, Tantalum, and Molybdenum from 0° to 1500° C. F. M. Jaeger & W. A. Veenstra. *Koninklijke Akademie van Wetenschappen Te Amsterdam,* Vol. 37, Feb. 1934, pages 61-66. **The Specific Heats and Thermal Retardation-Phenomena of Beryllium.** F. M. Jaeger & E. Rosenbohm. Vol. 37, Feb. 1934, pages 67-76. **A Redetermination of the Specific Heats of Palladium.** F. M. Jaeger & W. A. Veenstra. Vol. 37, May 1934, pages 280-283. Discussion of tests and test results presented in tabulated and graphical form. See *Metals & Alloys,* Vol. 6, Jan. 1935, pages MA 26 and MA 32. Kz (11a)

The Photoelectric Properties of the (100) and (111) Faces of a Single Copper Crystal. Newton Underwood. *Physical Review,* Vol. 47, Mar. 1935, pages 502-505. This paper is part of an investigation on electron diffraction. WAT (11a)

Crystal Structure and Electrical Properties. V. Surface Conductivity of Bismuth Crystals (Part 2). (Kristallstruktur und Elektrische Eigenschaften. V. Die Leitfähigkeitsflächen des Wismutkristalls (2 Teil)). O. Stierstadt. *Zeitschrift für Physik,* Vol. 93, Feb. 14, 1935, pages 676-691. Many conductivities exist at the same time on the surface of bismuth single crystals. The authors include photographs of models to illustrate these pulsating changes. FHC (11a)

Influence of Pickling on Properties of Duralumin. H. Sutton & W. J. Taylor. *Metal Cleaning & Finishing,* Vol. 7, Jan. 1935, page 36. Paper read before the British Institute of Metals. See *Metals & Alloys,* Vol. 5, Nov. 1934, page MA 534. GBH (11a)

11b. Ferrous

E. S. DAVENPORT, SECTION EDITOR

High Heat-Resisting Chromium-Cobalt-Aluminum-Iron Alloys (Ueber hochhitzebeständige Chrom-Kobalt-Aluminium-Eisen-Legierungen). G. Nordström. *Elektrowärme,* Vol. 5, Apr. 1935, pages 79-85. Alloys of Fe with 21.5% Cr, 2% Co and 3.7% Al, and 29.9% Cr, 0.1% Co and 5.4% Al are described. They are the latest development in metallic heating elements for high temperatures. The lifetime, according to the Bash-Harsh test (adoptd by the A.S.T.M.) was 157.7 and 121.3 hrs. respectively which is about 3 times as high as Cr-Al-Fe alloys without Co. Furnace temperatures of 1340° C. (2445° F.) could be safely maintained continuously, and even a 6-day heating at 1500°-1550° C. (2730°-2820° F.) in open air did not corrode the material very much. The m.p. lies at 1640° C. (2985° F.). The material is workable; wires of 0.02 mm. can be drawn, and wire of 6.5 mm. diam. can be coiled cold. It can also be welded with the d.c. arc; if acetylene and a flux are used the latter must be carefully removed to avoid subsequent corrosion. Examples of application in furnaces and household appliances are given. Ha (11b)

Some Observations on Sponge Iron and the Properties of the Direct Steel Made from It. R. S. Dean, E. P. Barrett & Calvin Pierson. *Metals Technology,* Jan. 1935, *American Institute Mining & Metallurgical Engineers Technical Publication* No. 592, 9 pages. Sponge Fe was made by reduction with natural gas and with carbon. The cell structure of the Fe ore could be readily determined by studying that of the Fe. Wrought Fe was made by briquetting the sponge Fe, heating to 1425-1450° C., and forging. The cell structure of the Fe was preserved in the wrought Fe and in steel made by melting the wrought Fe. JLG (11b)

Solubility of Nitrogen in Liquid Iron. John Chipman & Donald W. Murphy. *Metals Technology,* Jan. 1935, *American Institute Mining & Metallurgical Engineers Technical Publication* No. 591, 12 pages. Solubility of N_2 in electrolytic Fe was determined by melting Fe in an alundum crucible under a pressure of 1 atm. of N_2, determining N_2 content of cooled sample, and then applying a correction for N_2 evolved on cooling. The solubility of N_2 at approximately 740 mm. Hg was found to be 0.039% just above the m. p. and 0.042% at 1760° C. Within the limits of experimental error the solubility is not affected by 0.15% Al or by 0.070% Si. The rate of solution of N_2 in liquid Fe is not greatly influenced by temperature. Al or Si in the melt exerts a great influence on the rate of solution, the rate coefficient being increased tenfold to twentyfold in 2 experiments in which these elements were present. 10 references. JLG (11b)

Heat Resisting Alloys. W. F. Furman. *Industrial Heating,* Vol. 2, Apr. 1935, pages 187-190. Alloys used in the petroleum industry are reviewed; various Cr-Ni alloys and influence of C content are described and applications discussed. Ha (11b)

Thermal Expansion of Cast Iron (Der Ausdehnungsbeiwert von Gusseisen). E. Söhnchen & O. Bornhofen. *Archiv für das Eisenhüttenwesen,* Vol. 8, Feb. 1935, pages 357-359. The strongest effect on the thermal conductivity of cast iron is produced by C; the graphitization of cementite results in an increase in thermal conductivity. Large additions of Ni, Cu, and Al raise the conductivity, whereas the addition of Cr at first raises and then lowers the conductivity. SE (11b)

The Effect of Heat Treatment on the Elasticity of Steel. Geo. Laidler. *Modern Machine Shop,* Vol. 7, Nov. 1934, pages 28-30. The author points out that the modulus of elasticity of steel is independent of heat treatment and also of C content. When heat treating a piece of steel the elastic limit and ultimate strength may be raised but the resiliency remains the same; the resistance to elastic deflection remains the same. Ha (11b)

Problem of Materials (Beiträge zur Werkstofffrage). E. Rabald. *Chemische Fabrik,* Vol. 8, Jan. 23, 1935, pages 25-31. Cu-bearing and Patina steels have better corrosion resistance than ordinary steel. Several examples of actual service results are given. Perlit iron has better physical properties than common cast iron. The physical properties, heat treatment, working properties and uses of alloy, stainless and heat resisting steels are tabulated. Stainless clad steel and stainless steel castings have numerous uses. Steel containing 4.24% Cr, up to 3.5% Al and up to 1% Si is resistant to the action of H, hydrocarbons and S gases at high temperatures and is used in oil cracking equipment. 19 references. CEM (11b)

Effect of Very Small Amounts of Copper and Nickel on Carbon Steel (Einfluss kleinster Beimengungen von Kupfer und Nickel auf unlegierte Stähle). H. Bennek. *Stahl und Eisen,* Vol. 55, Feb. 7, 1935, pages 160-164. Steels of 0.1 and 0.9% C, with Ni and Cu contents from 0.01 to 2% were tested for red shortness, oxidation, decarburization, hardenability, and tensile properties. Cu and Ni contents in amounts up to 0.25% which is about all that may be expected to occur as residual "impurities" in commercial melts, had no deleterious effect on the rolling properties, irrespective of the C content. These elements had no significant effect on the hardness or tensile strength in the annealed or normalized condition. On quenching, however, the hardenability was definitely increased by amounts of Cu and Ni as small as 0.04%. SE (11b)

Some Experiments in the Duplication of the Intrinsic Properties of Cold-Blast Pig-Iron. J. E. Hurst. *Foundry Trade Journal,* Vol. 52, Feb. 21, 1935, pages 137, 138, 141. Differences between the characteristics and properties of cold-blast pig-irons and other types of pig-iron have been observed and experimentally investigated. It has been shown that the chemical composition, fracture and mechanical properties of cold-blast pig-irons can be very closely duplicated in all their characteristics by synthetic mixtures, and that irons which so duplicate these properties in entirety also duplicate the chilling characteristics. Such blended irons may possess a much greater degree of uniformity than cold-blast irons. AIK (11b)

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Alloys of Iron and Chromium. V. N. Krivobok. *Transactions American Society for Metals,* Vol. 23, Mar. 1935, pages 1-60; *Heat Treating & Forging,* Vol. 20, Oct. 1934, pages 500-505; Nov. 1934, pages 534-535; *Steel,* Vol. 95, Oct. 8, 1934, pages 41-42. Campbell Memorial Lecture presented at A.S.M. Convention, 1934. Fe-Cr alloys practically free from C and other impurities were studied and found to be susceptible to age hardening; they are subject to volume changes at elevated temperatures, and a sudden decrease in certain mechanical properties such as impact resistance at about 17% Cr. Effect of increasing Cr content on the Fe-C equilibrium was shown by means of animated drawings in a motion picture. Cr is found to have a great affinity for N_2 and the effects of its addition to Fe-Cr alloys are similar to those of C giving the alloys the ability to harden. The amount of N_2 in such alloys seems to be limited by the Cr content; for 18% Cr the equilibrium N_2 content seems to be about 0.2%; if the N_2 of the charge is more than this amount the gas will be evolved in melting; if less than this amount it will be absorbed if available in the atmosphere. WLC + MS (11b)

Titanium and Columbium in Plain High-Chromium Steels. Frederick M. Becket & Russell Franks. *Transactions American Institute of Mining & Metallurgical Engineers,* Vol. 113, 1934, pages 126-142. Includes discussion. See *Metals & Alloys,* Vol. 5, May 1934, page MA 225. (11b)

Effects of Columbium in Chromium-Nickel Steels. Frederick M. Becket & Russell Franks. *Transactions American Institute of Mining & Metallurgical Engineers,* Vol. 113, 1934, pages 143-162. Includes discussion. See *Metals & Alloys,* Vol. 5, May 1934, page MA 224. (11b)

Properties, Characteristics and Uses of Stainless Steels. S. A. Main. *Iron & Coal Trades Review,* Vol. 130, Mar. 22, 1935, pages 491-492. **The Stainless Steels.** *Engineering,* Vol. 139, Mar. 22, 1934, page 314 (abstract). Stainlessness and resistance to corrosion in the so-called stainless steels is due to their being covered by a protective film which acts in much the same but much more perfect way as a coating of lacquer or vaseline. At least 11% Cr must be in the steel to obtain this protective film. The characteristics of 18-8 steel are discussed at length. A fact not yet explained is that although this material is non-magnetic it becomes strongly magnetic when cold-worked although this does not happen with hot-working at temperatures above 250° C. The weld decay of 18-8 steel occurs not in the weld but in the material some little distance away from the joint. This was overcome by addition of a small amount of Ti, W, Si or Nb-Ta. The problem of corrosion is discussed in general, chances of eliminating corrosion entirely are held to be very negligible, and the best approximations in present alloy steels are the Cu steels. VSP + Ha (11b)

Copper Alloyed with Steel. C. H. Lorig. *Metal Progress,* Vol. 27, Apr. 1935, pages 53-56, 78. Summarizes data available on Cu as an alloy in steel where low percentages, less than 0.50%, increase atmospheric corrosion resistance and percentages up to 2% yield greatly improved physical properties and susceptibility to further improvement by age hardening. WLC (11b)

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Develops New Low-Alloy, High-Strength Steel for Transportation Field. HOWARD L. MILLER. *Steel,* Vol. 96, Apr. 29, 1935, pages 39-40. **Republic Develops "Double Strength" Steel for Railroad Applications.** *Iron Age,* Vol. 135, Apr. 25, 1935, pages 44, 74. The steel is made in two grades 1 and 1-A. Grade 1 contains a maximum of 0.12% C, and 1-A a maximum of 0.30% C. Both contain 0.50-1.00% Mn, 0.50-1.50% Cu, 0.40-0.80% Ni, and a maximum of 0.20% Mo. Minimum physical properties of normalized sheet, strip and plate are respectively: yield-point, 60,000 lbs./in.^{2} and 70,000 lbs./in.^{2}; tensile strength, 75,000 lbs/in.^{2} and 90,000 lbs./in.^{2}; and elongation in 2 in., 25% and 18%. Tempering sheets for 1 hr. at 900°-1000° F. increases physical properties 15,000-20,000 lbs./in.^{2} Steel has high corrosion resistance and can be fabricated without difficulty. It has little tendency to air harden and can be satisfactorily welded. Material under 16 gage should be spot welded, while 16 gage or heavier can be arc welded. Use of this steel permits considerable reduction in thickness of sections as compared with ordinary structural grades of steel. VSP + MS (11b)

Alloying of Chilled and Roll Castings (Ueber das Legieren von Hart-und Walzenguss). E. SCHARFFENBERG. *Giesserei,* Vol. 22, Jan. 18, 1935, pages 31-35. Although systematic experiments proved the possibility of producing, under carefully chosen conditions, rolls of chilled cast iron of desired quality and a surface hardness of 600 Brinell without alloying with Cr, Ni or Mo, general practice now prefers rolls for hot or cold-rolling whi chcontain different amounts of these elements as wearing resistance is considerably better. Mo alone seems to be superior to Mo-Cr and Cr-Ni in reducing wear. Rolls for cold-rolling should have a martensitic surface structure. The effect of different additions of Mo, Cr and Ni on the formation of the surface structure is discussed and illustrated by micrographs. Roughing rolls of Mo alloy iron have given the best results for tinplate. Cr and Cr-Mo have been abandoned. Ha (11b)

Investigation on the Demagnetized Structural Field of Ferro-Magnetic Materials (Recherches sur le champ dêmagnétisant structural des ferromagnétiques). TH. KAHAN. *Journal de Physique et le Radium,* Vol. 5, Sept. 1934, pages 463-478. The internal demagnetization factor N_s which depends on the structure of the ferro-magnetic material is determined for Co and Ni in relation to temperature. N_s becomes smaller with rising temperatures. The structural changes are discussed in the light of the newly established phenomenon. EF (11b)

Steel, Report of A.S.T.M. Committee A-1. *Proceedings American Society for Testing Materials,* Vol. 34, Pt. I, 1934, pages 60-74, **Appendix. Proposed Revisions in Standards and Tentative Standards for Steel,** pages 75-83; discussion, pages 84-86. Progress report on specifications. Four proposed tentative standards were submitted during the past year: A 154-33T for Carbon-Steel Castings for Industrial, Railroad and Marine Uses; A 7-33T for Steel for Bridges; A 9-33T for Steel for Buildings; and A 10-33T for Mild Steel Plates. VVK (11b)

Standard Specifications for Carbon-Steel Castings for Valves, Flanges and Fittings for High-Temperature Service. *American Society for Testing Materials Designation* A 95-33; *American Standards Association* A.S.A. No.: G 17.1-1934, 5 pages. The specification covers heat treatment, chemical composition, physical properties, etc. AHE (11b)

12. EFFECT OF TEMPERATURE ON METALS AND ALLOYS

L. JORDAN, SECTION EDITOR

The abstracts in this section are prepared in co-operation with the Joint High Temperature Committee of the A.S.M.E. and the A.S.T.M.

Effect of Furnace Atmospheres on Scaling of Annealed Steel Sheets (Der Einfluss der Ofenatmosphäre auf das Zundern geglühter Stahlbleche) *Die Metallbörse,* Vol. 24, Nov. 24, 1934, page 1499. The effect of O, SO_2 and CO_2 on the formation of scale is discussed. A comparison between different fuels showed that scaling increases with rising H contents in the fuel, thus placing coke with 0.3-0.9% H at one end of the scale and mineral oil with 12-13% H at the other end. According to experiments of the author, the scaling effect on 10 mm. steel sheets annealed at 950° C. in 2 identical furnaces amounted to 1.95 kg./m.^{2} and 1.40 kg./m.^{2} respectively for the oil and coke-fired furnace. When using coal, the scaling was 1.75 kg./m.^{2} In these tests, the absence of O was insured. With an excess of 2.5% O, scaling under comparable conditions increased from 1.35 kg./m^2 to 6 kg./m.^{2} To counteract scaling, it is urged: (1) to observe purely reducing furnace atmospheres with no soot or smoke formation, (2) to utilize high temperature coke low in H_2O and H or its corresponding producer gas and (3) to use fuel low in S. EF (12)

The Elastic Properties of Steel at High Temperatures. GUY VERSE. *Transactions American Society of Mechanical Engineers,* Vol. 57, Jan. 1935, pages 1-4. Modulus of elasticity and modulus of rigidity of steel are determined at temperatures up to 500° C. by static and dynamic methods. Within certain limits the results are practically independent of the rate of loading which is apparently due to a strain-hardening effect occurring upon loading and detected upon unloading. Comparison between static and dynamic tests shows that the values of the modulus of elasticity and that of rigidity when determined statically under decreasing loads (according to the method of Everett) are close to the values obtained dynamically, and somewhat lower for temperatures above 400° C. If the values are determined statically under increasing loads they are not reliable owing to the difficulty of discriminating between elastic and plastic deformation. Values determined dynamically are the most reliable. The variation of Poisson's ratio with temperature is represented by the formula $\mu = (E/2G) - 1$ where E and A are the 2 dynamically determined moduli. 7 references. Ha (12)

Thermal Behavior of Metals at the Lowest Temperatures (Das kalorische Verhalten von Metallen bei den tiefsten Temperaturen) WILLEM H. KEESOM. *Forschungen & Fortschritte,* Vol. 10, Dec. 1, 1934, page 421. Referring to experiments at the Kamerling Onnes Institute at Leyden, Holland, the following points are covered: (1) specific heat of free electrons, (2) thermal behavior of supra-conductors, (3) heat capacity of electrons in the supra-conducting and ordinary state. EF (12)

Calorimetric Measurements at Extremely Low Temperatures (Études calorimétriques aux temperatures extrèmement basses). W. H. KEESOM. *Journal de Physique et le Radium,* Vol. 5, July, 1934, pages 373-384. Describes apparatus, devised at the author's laboratory at Leyden, for determining specific heats in the vicinity of absolute zero. Electric resistance data for P-bronze, Ce, Mg at extremely low temperatures are graphically presented. EF (12)

Magnetic Phenomena at the Beginning of Supra-Conductivity (Magnetische Effekte bei Eintritt der Supraleitfähigkeit). W. MEISSNER, R. OCHSENFELD & F. HEIDENREICH. *Zeitschrift für die gesamte Kälteindustrie,* Vol. 41, Aug. 1934, pages 125-130. Paper before the General Meeting of the Deutscher Kälte-Verein, Berlin, May, 1934. Reports experiments, which, contrary to previous hypotheses and calculations, proved a divergence of the lines of force around a supra-conductor at the moment the phenomenon of supra-conductivity shows up. An analogous effect occurs at the magnetic Curie point of ferro-magnetic materials. However, the permeability increases considerably on lowering the temperature below the Curie point, whereas no convergence of the lines of force takes place at temperatures lower than the critical temperature of supra-conductivity. An extensive study of the effect of various magnetic fields on Sn (single crystals, tubes, wires) Pb and Cu is fully reported. EF (12)

Electric Conductivity at Low Temperatures. R. PEIERLS. *Physikalische Zeitschrift der Sowjetunion,* Vol. 6, No. 5, 1934, pages 516-519. In English. In a previous paper (See *Physikalische Zeitschrift der Sowjetunion,* Vol. 5, No. 2, 1934, page 115), S. V. Vonsovsky and A. A. Smirnov derived that the conductivity would be proportional to T^{-3} while calculations of Bloch and others have led to a T^{-5} law. The author shows that the argument of the Russian scientists contains an error. EF (12)

Magnetic Induction of Supra Conducting Lead in Relation to the Magnetic Field (Über die Abhängigkeit der magnetischen Induktion des supraleitendenden Bleis vom Feld) H. J. RJABININ & L. W. SCHUBNIKOW. *Physikalische Zeitschriftder Sowjetunion,* Vol. 6, No. 6, 1934, pages 557-568. Two different methods for measuring the magnetic induction in supra-conducting metals in varying fields and at different temperatures were developed, and experiments on Pb at extremely low temperatures are reported. EF (12)

Specific Heats of Supra-Conducting Alloys (Spezifische Wärme von supraleitenden Legierungen) L. W. SCHUBNIKOW & W. J. CHOTKEWITSCH. *Physikalische Zeitschrift der Sowjetunion,* Vol. 6, No. 6, 1934, pages 605-607. In analogy to pure Pb, no break in the specific heat-temperature curve of a Pb-Bi alloy could be detected. The formula of Gorter referring to the specific heat changes of a metal on passing into the supra-conducting state does not hold for alloys. EF (12)

13. CORROSION AND WEAR

V. V. KENDALL, SECTION EDITOR

The Electrochemical Behavior of the Tin-Iron Couple in Dilute Acid Media. T. P. Hoar. *Technical Publications of the International Tin Research and Development Council,* Series A, No. 5, pages 472-482. Reprinted from *Transactions of the Farady Society,* No. 157, Vol. 30, Part 6, June 1934. The resistance to chemical influences of the tin coating of tinplate is investigated in the light of the local elements Sn | electrolyte | Fe which are formed by the always present minute cracks and pores where the electrolyte can enter. The mechanism of the reactions is discussed. Sn functions as anode in dilute acid (citric, oxalic) owing to the removal of Sn ions as complexes, and it functions as cathode in H_2SO_4 where no complex is formed. Air increases the corrosion, the acidity has no marked effect. The bearing of the results on corrosion of tin cans is discussed. Ha (13)

The Problem of Corrosion: Its Solution by the Use of Corrosion Resisting Steels (Le Problème de la Corrosion: sa Solution par les Aciers Inoxydables). Henri Leroux. *Science et Industrie (Métaux et Machines),* Vol. 18, Dec. 1934, pages 341-344. Reviews all means which have been tried or which are in use for protection against corrosion. Alloys are classified as follows (a) ferrous alloys without Cr (e.g. 25-35% Ni steel, Ni steel with costly additions, high alloy cast Fe, Fe-Si alloys) (b) ferrous alloys containing Cr. The latter are in turn divided into 3 classes. (1) Steels containing Cr only (martensitic and austenitic). (2) Austenitic Ni-Cr steels with or without additions. (3) Alloys containing large quantities of Ni and Cr and in which Fe is not the chief component. The article includes an historical survey of corrosion resisting steels. FR (13)

Corrosion of Wrought Iron and Steel. Raymond Morgan, Paul D. Dalsimer & Newbern Smith. *Journal Franklin Institute,* Vol. 219, Feb. 1935, pages 157-165. Tests made by means of time-potential curves show that there is a higher initial corrosion rate for wrought iron than for steel in M/10 KCl solution. The time-potential curves after 20 to 30 minutes tend to converge for all samples of wrought iron and steel annealed and unannealed. FHC (13)

Corrosion of Non-Ferrous Metals and Alloys, Report of A. S. T. M. Committee B-3. *Proceedings American Society for Testing Materials,* Vol. 34, Pt. I, 1934, pages 221-243. **Report of Sub-Committee VII on Corrosion in Liquids,** pages 222-235. The program described in the 1932 report (Vol. 32, Pt. I, page 243) was organized to develop standard laboratory corrosion tests. At present, weight loss data on 315 specimens exposed to sulphuric acid and tension test data on 162 of the corroded specimens are available. A description of the apparatus and tests in sodium chloride, sodium hydroxide and sulphuric acid is given. Data on the specimens exposed to sulphuric acid are given in the form of tables. The committee concludes that the measurement of corrosion involves changes of weight, physical properties, and the nature of corrosion, whether uniform or localized, and that these factors should be taken into consideration in designing a standardized corrosion test. "From the data available now, it appears that some group of metals might be arranged according to corrosion resistance in almost any order by an experimenter who was privileged to manipulate the test conditions and to select some one unit of measure, such as change of tensile strength. The fact that various arrangements may be obtained from the same group of metals when an experimenter is given latitude, stresses the importance of defining with adequacy and precision the methods to be followed in making a standardized corrosion test and in measuring the results. Obviously, standardized laboratory corrosion testing is not a matter to be taken lightly when the probable performance of materials in service is to be predicted with accuracy." **Report of Sub-Committee VIII on Galvanic and Electrolytic Corrosion,** pages 236-243. Data are reported for all the couple combinations of Zn, Al, Fe, Ni, Cu, Sn, and Pb for the period of 1 year at 9 atmospheric locations. No conclusions are drawn as the committee considers it best to await data from the more extended exposure periods. VVK (13)

Salvaging Washout Tank. R. J. McWaters. *Metallizer,* Vol. 3, Jan. 31, 1935, pages 2-3, 6, 11. Complete data are given on time, materials and cost of Zn spraying a 15,000 gallon locomotive washout tank in Canada. A charge of 75c/ft.^{2} was considered fair for work of this nature, including all materials and sand blasting. Zn used to spray the 1270 ft.^{2} of surface amounted to 560 lbs., acetylene 1,400 ft.^{3} and oxygen 1,500 ft.^{3} BWG (13)

Some Factors in the Maintenance of Tin Meters. C. L. Nairne. *Gas Age Record,* Vol. 74, Aug. 25, 1934, pages 165-169, 172. Presented before 26th Annual Convention Southern Gas Association, Memphis, Tenn. An investigation by the New Orleans Public Service, Inc. of the corrosion problems of tin meters led to the development of a first coat of zinc dust primer with a finishing coat of quick-drying bakelite enamel for exterior protection. When exposed to hot sun, a coat of aluminum paint was also applied. Application by spraying was adopted. The interiors of the meters were coated with a bakelite clear varnish which seems to be impervious to the action of air, oil and water. Meter repair procedure is described and illustrated by a flow diagram. VVK (13)

Water As An Engineering and Industrial Material. Sheppard T. Powell. *Proceedings American Society for Testing Materials,* Vol. 34, Pt. II, pages 3-47. A comprehensive review of the use of water from an engineering standpoint including removal of suspended solids from water, effect of color on industrial water supplies, effect of manganese in industrial water supplies and its removal, treatment of water for use in boilers, influence of concentrated boiler-water salines on cracking of boiler steel, corrosion of iron and steel in steam generating stations, reduction of corrosion losses by deaeration, and the spectrographic analysis of water. 63 references. VVK (13)

Spraying Machine Elements. Roy Sofield. *Metallizer,* Vol. 3, Jan. 31, 1935, pages 4-5. More information is given on the use of metal spraying for salvaging rejected, defective and worn machine parts. In some instances it may actually cost more to coat the part by metal spraying than to buy a new part but by coating with a more corrosion resisting or wear resisting metal the life of the part may be very greatly extended. BWG (13)

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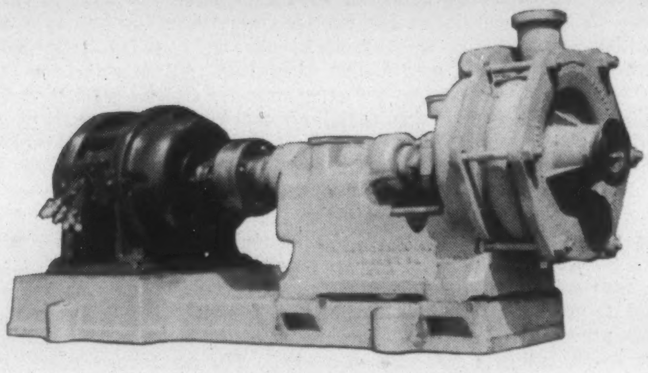

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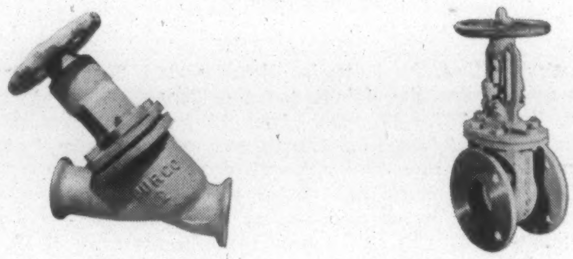

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Corrosion, Causes and Prevention. F. N. Speller. 2nd Edition. McGraw-Hill Book Company, New York, 1935. Cloth, 6 x 9¼ inches, 694 pages. Price $7.00.

The first edition, published in 1926, is recognized as the leading discussion of corrosion of iron and steel from the engineering point of view. In the interim some 3000 articles on corrosion have appeared and both theory and practice have advanced. The essential soundness of the earlier edition is shown by the fact that the author has not found it necessary to alter or greatly modify the principles he previously expounded. The additions, amounting to 73 pages, serve chiefly to clarify, and produce more evidence in favor of, the statements previously made. This edition is up-to-date, but the former one is not badly out of date. Besides the general revision and clarification of the whole, some topics are more extensively treated, expecially those on petroleum refining problems and underground pipe line corrosion. A good many interesting comments are slipped in that were not in the first edition, e.g. that corrosion tests in air, water and soil on open hearth steel made from direct (sponge) iron showed no difference between this steel and ordinary steel made from pig and scrap, mention of Izett steel to resist caustic embrittlement, the value of nickel steel for use in salt water carrying H_2S, and deactivation of oxygen-containing water by treatment with sodium sulphite. The discussion is concerned almost wholly with iron and steel, including galvanized steel. Many interesting questions such as those on intercrystalline corrosion of aluminum alloys, deterioration of copper piping and brass condenser tubes, season cracking corrosion of bearing metals by blended oils and the like, which confront the non-ferrous metallurgist are left untouched. It would of course take another equally large volume to deal with these problems as adequately as has been done in regard to ferrous alloys, but it would be helpful if Dr. Speller would further apply his powers of clear thinking and clear writing and correlate the non-ferrous and the ferrous subjects into one discussion. The non-ferrous alloys, chiefly as materials for chemical plant construction, are listed and briefly discussed, but the treatment is comprehensive, even in respect to theory, only as to ferrous alloys. However, from the point of view of tonnage involved, the problems on which Dr. Speller does give comprehensive and clear cut discussion do cover the great bulk of the corrosion engineer's difficulties. This edition maintains the standard set by the first one, and when one is looking for authoritative information on corrosion, he will continue to reach for Speller's book first of all.

H. W. Gillett (13)—B—

Electrochemical Methods for Protecting Metals against Corrosion (Procedes Electrochemiques de Protection des Metaux Contre la Corrosion). P. Jacquet. Hermann et Cie, Paris, 1934. 42 pages. Price 12 Fr. This pamphlet is No. 163 of the series entitled "Actualities Scientifiques et Industrielles," of which the electrochemical numbers have been prepared under the direction of Ch. Marie. This book is a concise presentation of the principles of corrosion, and of protection against corrosion by metallic coatings and oxide films. The author summarizes the results of his own studies upon the protective value of Ni, Cr, Zn and Cd coatings, and compares them with the results of other investigations. In general, the results of Jacquet are consistent with those recently published by the National Bureau of Standards.

W. Blum (13)—B—

Metallurgical Data on Fusion Weld Joints. A. J. Moses. *Journal American Welding Society*, Vol. 14, Apr. 1935, pages 5-19. Control of weld quality is shown to be entirely a metallurgical operation especially with respect to control of differential potentials between weld and parent metal and thus control of galvanic corrosion. The desirability of maintaining chemical uniformity in the joining of materials is shown in several corrosion studies of 18-8 weld in 16-18 Cr iron which corroded badly at the junction zone in the HNO_3 corrosion test. Welds of 16-18 Cr iron in parent metal of same type and 18-8 weld in 18-8 parent metal both with proper anneal showed no zone of increased corrosion in HNO_3 test. An 18-8 weld in 16-18 Cr is shown which received a 1450° anneal and furnace cool, which is proper anneal for the 16-18 Cr but in the HNO_3 test the 18-8 weld was badly corroded, showing improper anneal for the weld. A chart is given which shows the chemical variations that may or do occur in the common materials, plate, rivets, forgings, steel tubes, iron tubes, steel castings and cast iron that are used in the construction of pressure vessels. Another chart summarizes the actual chemical variations found in a large number of analyses of bare-wire weld metal, coated-rod weld metal and plate stock of 55-65,000 tensile steel. The non-metallic inclusions are considered mainly responsible for potential differences leading to galvanic action while metallic impurities are harmless as such but if badly segregated may promote galvanic action. The controlled fusion weld joints are shown to be remarkably free from such impurities as compared with electric arc fusion with unshielded arc or in hammer welded joints. Hammer welds are especially objectionable because of entrapped slag. Poor quality weld structures are shown for heavily coated rod and improper welding technique, giving rise to high N_2 absorption and formation of nitrides. Accelerated corrosion occurs where the N_2 is precipitated as nitride needles when slightly in excess of .04% N_2. Bare wire welding is shown to lead to dirty welds and accelerated corrosion. Stress relieved fusion welded boiler drums have practically eliminated failures due to caustic embrittlement. Lack of stress relief after welding is shown in macrograph to cause differential corrosion rate while the same weld after stress relief is uniformly corroded. The use of X-ray "Laue Patterns" for determining magnitude of stress in welded structures is suggested and illustrated in several X-ray photos of strained and stress relieved material. The grain size of the various structures is determined at the same time as is the stress. A series of micros going progressively from the parent metal through to the welded area are shown for poor and for good quality welds. An appendix gives the results of corrosion tests and the method of sample preparation. Throughout the entire paper the statements are admirably backed up by clear photos of actual results and by tabular data.

WB (13)

The Equilibrium of $Sn + 2H_2O \rightleftarrows SnO_2 + 2H_2$ (L'équilibre $Sn + 2H_2O \rightleftarrows SnO_2 + 2H_2$). G. Meyer & F. E. C. Scheffer. *Recueil des Travaux Chimique des Pays-Bas*, Vol. 54, Mar. 15, 1935, pages 294-298. The disagreement of previous work by Wöhler & Balz, Eastman & Robinson and Emmett & Shultz is pointed out. The experimenters arrived at the following equations $\log K = \frac{2301}{T} - 2.693$. Determination of the reaction heat of the equation $Sn + 2H_2O \rightleftarrows SnO_2 + 2H_2$ yielded 21.0 cal. as compared with a theoretical value of 21.7 cal.

EF (13)

A Vectoral Method of Reporting Electrolysis. B. A. Williamson. *Gas Age Record*, Vol. 72, Oct. 27, 1934, pages 372, 374. Paper presented before the Pacific Coast Gas Association, Del Monte, Calif., Oct. 1934. In making electrolysis surveys the author has made use of a bright pipe electrode placed in the soil adjacent to the pipe line and connected to it through a recording milliammeter. He now describes a graphical vectoral method of recording the data which has the advantages of: (1) corrosion data for many test locations on a pipe line can be presented on a single sheet; (2) the location of the vectors on the sheet gives at once an idea of the relative safety of the pipe line at the various locations; and (3) at a glance may be seen the relative intensities of the galvanic and leakage current electrolysis components, whether they are additive or subtractive, and their average 24-hour value.

VVK (13)

The Electrochemical Potential of Iron and its Corrosion Behavior (Über das elektrochemische Potential des Eisens und die Korrosionserschinungen). N. Nekrassow. *Zeitschrift für Elektrochemie*, Vol. 41, Jan. 1935, pages 2-9. Low C (0.2) iron sheets were corrosion tested in dilute aqueous solutions of various salts, neutral, weakly basic and basic. The dilute solutions were used (.01 N to .1 N max.) to simulate "natural" corroding conditions. A check was made of the weight-loss method by testing the amount of Fe in the solution and corrosion products by colorimetric methods. For very slight weight losses the colorimetric determination checks excellently with weight loss. The potential determination of the Fe was made in the same solutions at various H ion concentrations. The pH value of the solution at which corrosion is retarded, is shown to be dependent upon the anion present or the combination of anions present in the solution. The presence of SO_3'' in small amounts increased corrosion and the protective action of this ion on corroding iron manifests itself only when present in the solution to a concentration greater than .0005 N. Oxalate and acetate ions were found to be protective. In the absence of protective ions the corrosion velocity is the same after 24 hours as it was originally, provided the oxygen concentration of the solution has not decreased. A close relationship between metal potential and corrosion rate is established by the tests made. A shift of the potential toward the hydrogen (negative) side is coupled with increasing corrosion rate and a decreasing corrosion rate is accompanied by a shift in the potential toward the oxygen (positive) side.

WB (13)

Wear of Steel Rails (Zur Frage des Schienenstahlverschleisses). E. Cotel. *M. Kir. Joszef Nador Müszaki es Gazdasagtudomanyi Egyetem Banya-, Koho- es Erdömernöki Kar,—Sopron (Royal Hungarian Palatin-Joseph University of Technical and Economical Sciences, Faculty of Mining Metallurgy and Forestry of Sopron)*, Vol. 6, Dec. 1934, pages 5-18. The "classical" methods of testing materials do not permit judging in advance the wear of a steel rail. Besides, the practical way of stressing rails in testing is not a pure wearing process but often a working process. Wear tests are described which show that the wear resistance of unalloyed steel rails with 0.4 to 0.9% C increases linearly with increasing C content. The same ratio as between tensile strength and wear exists also for hardness and wear for a given heat-treatment. As C content is the only determining factor of wear and as C can be determined with absolute reliability other wear tests by the modern wearing machines are considered superfluous when the relation between C content and wear has once been determined. The pearlitic structure is the best for low wear. Steels for tracks with steep grades and many curves should be selected more from the point of view of workability than of wear resistance as the rails have to be cut, drilled and fitted *in situ*. Horizontal and straight tracks do not require high C content as their fabrication is more expensive. Experience of the Hungarian State Railroad shows that the soft rails with 0.42% C laid 42 years ago have had only a very slight wear in spite of the great annual ton-miles carried.

Ha (13)

Hints for the Designer Regarding Corrosion Prevention in Steel Construction (Konstruktionswinke für den Korrosionschutz im Stahlbau). Adrian. *Farben Zeitung*, Vol. 39, Nov. 10, 1934, pages 1146-1147; Nov. 17, 1934, pages 1170-1172. Paper before the Fachausschuss für Anstrichtechnik, Frankfort on the Main, Oct. 19, 1934, discusses economic maintenance of steel construction and shows with the aid of over 20 illustrations how the corrosion of structural steel work can be minimized by proper design.

EF (13)

Tractor Group Talks Engine Wear at Chicago. *S. A. E. Journal*, Vol. 36, Jan. 1935, pages 9-12. Discussion group on wear and corrosion of engine and engine parts.

WB (13)

Electrochemical Corrosion and Its Prevention (Die elektrochemische Korrosion und ihre Bekämpfung). Kurt Nied. *Werkstoffe & Korrosion*, Vol. 9, Oct. 1934, pages 37-38; Nov. 1934, pages 41-42. The cause of corrosion is, in the majority of cases, of electrochemical nature. Methods of eliminating corrosion by insulation or by directing the corroding current so that a protecting material is attacked and not the metal itself, are discussed. Several examples of protective measures are described, in particular the application of auxiliary currents to counteract the destruction of sewers, rails, etc., by stray currents from electric railways. See also *Metals & Alloys*, Vol. 5, Mar. 1934, page MA 80.

Ha (13)

Influence of Oxide Films on the Wear of Steels. S. J. Rosenberg & L. Jordan. *Mechanical World & Engineering Record*, Vol. 96, Nov. 2, 1934, pages 415-416. See *Metals & Alloys*, Vol. 5, Nov. 1934, page MA 540.

Kz (13)

Recent Developments in Marine Flushometers. *Marine News*, Vol. 21, Jan. 1935, page 44. Galvanic corrosion of adjacent metal parts of flush-valve prevented by encasing the metal in a bakelite material and insulation. Service tests have shown the poles of the couple to be changed, where previously the metal was corroded, deposition of mineral salts is said to take place.

WB (13)

Corrosion in Superheated Steam Lines (Korrosion in der Heissdampfleitung). *Die Wärme*, Vol. 57, Aug. 25, 1934, page 555. Pipe lines carrying steam at 20 atm. and 380°-420°C. exhibited corrosion pits of from 3-10 mm. diam. and 1-4 mm. depth which were distributed in a peculiar manner. Investigation revealed that an excess of soda from the boiler water conditioning entered the boiler and at the prevailing boiler pressure about 77% of the soda decomposed and liberated CO_2 which, although O_2 was absent, was the source of trouble. This could be confirmed definitely after the installation of a new feed water softening plant.

EF (13)

Soil-Corrosion Studies, 1932. Rates of loss of Weight and Pitting of Ferrous and Non-Ferrous Specimens and Metallic Protective Coatings. K. H. Logan & R. H. Taylor. *Bureau of Standards Journal of Research,* Vol. 12, Jan. 1934, pages 119-145. This report of the Bureau of Standards soil corrosion investigation deals only with data on specimens removed in 1932 after 10 yrs. soil exposure. Consideration of these data does not materially alter the conclusions reached earlier that the character of the soil controls the rates of corrosion of ferrous materials and that in the same soil all of the commonly used ferrous materials corrode at nearly the same rate. For the soils investigated, the rate of corrosion in a soil of a given series as identified by the United States Department of Agriculture appears to be characteristic of the series and it seems probable that the rate of corrosion in any location in a soil belonging to a known soil series can be predicted when the corrosiveness at one location in that series has been determined, provided the location of the pipe with respect to the soil horizons of the series is taken into account. Metallic protective coatings show signs of failure, after 8 years in several of the more corrosive soils. Several non-ferrous metals and alloys are more resistant to soil action than the ferrous materials commonly used. The data presented are for the more corrosive soils and do not represent an average corrosiveness of all soils. There are indications that the rate of corrosion decreases with time due to more stable trench conditions and to protection of corrosion products. The decreasing rate indicates that ultimately a fixed rate of corrosion may be reached. Cu, and alloys high in Cu, corrode less rapidly than most ferrous materials in the soils investigated. A Zn coating weighing 1 ounce per square foot of exposed surface should extend the life of the coated material at least 6 years in very corrosive soils and much longer under more favorable conditions. WAT (13)

Accelerated Testing Device Determines Protective Value of Coating on Steel. *Steel,* Vol. 96, Feb. 11, 1935, pages 47, 49. Machine known as the "Weather-O-Meter" is used for giving coated steel panels accelerated tests equivalent to an outside weather exposure of 1½-2 years. Panels, placed on a circular rack, are alternately doused with cold H_2O and dried, heated, and exposed to ultra-violet rays once every 7½ min. This gives effect of continual change from wet to dry, sunshine to shadow, hot to cold, with accompanying expansion and contraction of surface. MS (13)

Wax Coated Rubber Rings Used in Multiple Corrosion Tests on Paint. *Steel,* Vol. 96, Feb. 4, 1935, page 49. Sherwin-Williams Co. has developed a spot method for making tests of chemical resistance of paint films. Rubber rings are cut from inner-tube stock and are immersed in a melted mixture of 50 parts paraffin, 20 parts carnauba wax, and 30 parts Halowax 1013. Panel is placed under a hot H_2O tap reverse side up, to prevent chilling of wax when rings are placed on panel. Rings are pressed at several points, and when wax has lost surface gloss, a 2000-gram brass weight is applied. One cc. of reagent is poured into each ring. Microscope slides are used for covers. MS (13)

Converters for Tar Hydrogenation. A. T. Barber & A. H. Taylor. *Mechanical World & Engineering Record,* Vol. 96, Dec. 28, 1934, pages 625-626, 628. Abstract of a paper "High Pressure Plant for Experimental Hydrogenation Processes," presented before the Institution of Mechanical Engineers. Deals with the construction of special converters for the continuous operation. Serious trouble was caused by corrosion. Results obtained by the application of Ni-Cr steel and Cr-Mo steel as material for converters and pyrometer wells are discussed. Kz (13)

Macroscopic Coloration Tests (Essais de Macroscopic Colorée). M. Prot & Mlle. Goldowski. *Chimie et Industrie,* Vol. 32, Special Number, Apr. 1934, pages 442-443. When different metals or heterogeneous alloys are placed in an electrolytic medium, the couple between the different metals and the different constituents of the alloys and the concentration of hydrogen ions in the solution becomes heterogenous. A colored pH indicator will show this heterogeneity. By utilizing indicators of this kind and by stabilizing the medium with a suitable colloid the authors have been able to arrange a practical method whereby these susceptible heterogeneities are found to be the origin of dangerous corrosive agents, particularly in alloys of the duralumin family. MAB (13)

Caustic Embrittlement in Boilers. An Examination of Phenomena, Causes and Cares. *Commonwealth Engineer,* Vol. 22, Jan. 1, 1935, pages 177-185. Discusses the inherent structure of boiler steels and the differing characteristics of cracks produced by fatigue, corrosion fatigue and caustic embrittlement as revealed under the microscope. Regarding caustic embrittlement the following summations are made: (1) Caustic embrittlement can occur if the feed water contains excess of soda either naturally or added. (2) It is usually manifested by cracks appearing on the dry side of the seam and on rivet heads and by the falling off of the latter while the boiler is in operation. (3) The cracks and broken rivets invariably occur below the water-line. (4) The cracks are irregular in shape and the majority are of intercrystalline type. A few odd cracks of trans-crystalline type are in evidence but cannot be taken as proof that caustic embrittlement has not occurred. Neither can the occurrence of a few odd cracks of intercrystalline type be taken as proof of caustic action in cracks of other types. (5) Leakage at rivet heads and along seam plates should be taken as an indication that embrittlement may be present, which becomes more definite with an easy removal of rivet heads below the water-line. (6) Caustic embrittlement can be prevented by (a) maintaining the correct carbonate/sulphate ratio, (b) by the use of tribasic sodium phosphate (c) by both. Considerable assistance will also be afforded by (d) internal caulking (c) painting the interior with an inert boiler compound. (7) If proper precautions are taken, the use of caustic soda as a feed conditioning agent is safe. WH (13)

Testing for Pipe Line Soil Corrosion in California. John C. Albright. *Oil Weekly,* Vol. 77, Apr. 8, 1935, pages 29-32. Discussion of the field and laboratory methods for testing the corrosivity of soils. Kz (13)

Corrosion and other Kinds of Destruction of Pipe Material of Underground Constructions (Korrosionen und sonstige Zerstörungen am Rohrmaterial des Tiefbaus) C. Abweser. *Korrosion & Metallschutz,* Vol. 11, Mar. 1935, pages 59-64. The different corrosion phenomena occurring especially in Fe and Pb tubes used in underground structures are discussed and protective coatings of a bituminous nature described. Damage by stray currents and their prevention is also discussed, and attention is called to injuries due to frost and mechanical action. Ha (13)

Improved Paints Spur Attacks on Corrosion Problems. James O. Hasson. *Steel,* Vol. 96, Mar. 11, 1935, pages 30-33. Discusses use of industrial paints for protection of steel against corrosion. Best primers contain $PbCrO_4$. Vehicle should be blended from linseed oil resins, and tung oil. Finishing paint which is nearest to an all-purpose metal protective paint is the combination graphite paint possessing H_2O-shedding properties characteristic of C and graphite paints. Where heat reflection is desired, Al, white, or light tints are specified. Basic ZnO is generally used for finishing coat on gas-holders. Some acid- and alkali-resistant finishing coats contain synthetic resins. Pipe-lines are given extra-heavy coatings of tar pitch and graphite paints and a plastic cement finishing coat. Metal surface must be properly prepared. Good primer for galvanized surfaces is a Zn dust-ZnO paint. MS (13)

Oil Well Casing of Bessemer Steel Shows Little Deterioration After 21 Years. G. A. Reinhardt. *Steel,* Vol. 96, Apr. 22, 1935, pages 28-30. Two strings of casing, which had served satisfactorily for 21 years under practically identical external conditions in wells located a few 100 ft. apart, were pulled recently. One, of Bessemer steel, showed practically no corrosion. Other, of wrought-Fe, was considerably corroded and deeply pitted externally, so that effective wall thickness was reduced 30%. Chemical analyses, physical tests, and metallographic examinations were made on samples of each. Composition is typical of good quality in each type of material. Physical properties conform in all respects with present standard specifications. Wrought-Fe corroded because of its heterogeneous structure, galvanic action evidently being set up by contact of casing with ground waters. Steel did not set up galvanic action, due to its uniform structure and composition. MS (13)

Metallic Rust-Proof Finishes for Architectural Ironwork. I. G. Slater. *Electrical Review,* Vol. 116, Feb. 15, 1935, page 240. Abstract of lecture arranged by the Building Centre, London, Jan. 31, 1935. Deals with corrosion and protective coatings. Most of the metals used commercially for this purpose can be deposited by electrolysis, which can be controlled more completely than other methods. MS (13)

The Lubrication Requirements of Automotive Worm Gearing. C. H. Schlesman. *S. A. E. Journal,* Vol. 36, Apr. 1935, pages 147-158. Lubrication of worm gears is discussed for prevention of failure through compression fatigue or pitting and other types of wear or corrosion occasioned by improper lubrication. WB (13)

Possibilities of Corrosion protection of Metals (Betrachtungen über die Möglichkeiten des Korrosionsschutzes von Metallen). M. Straumanis. *Korrosion & Metallschutz,* Vol. 11, Mar. 1935, pages 49-53. The discussion of corrosion processes of metals must lead to the conclusion that it is impossible to protect a base metal entirely from corrosion as it always has the tendency to reduce its free energy by passing into the ionic state i.e. to corrode. It is possible only to retard the velocity of this process. This velocity depends on the activity of local elements (as the now generally accepted theory supposes) for which a mathematical expression is given from which it can be derived that alloying with a nobler metal (Cr in Fe) is one way of reducing this velocity, or by connecting the metal electrically with a baser metal (e.g. a machine part with Zn). The electrolytic conditions in forming local elements and the action of O are explained. 15 references. Ha (13)

Comparative Measurements of Corrosion in Refrigeration Brines (Vergleichende Messungen über Korrosion in Kühlsolen). Albrecht Steinbach. *Zeitschrift für die gesamte Kälteindustrie,* Vol. 41, June 1934, page 121. Polemic against a previous paper of Schwaibold & Wiesent (See *Metals & Alloys,* Vol. 5, Dec. 1934, page MA 588 R-9) on corrosion of Fe in various commercial refrigerator brines of "special low aggressiveness." The author obtained quite different results which, however, agree well with experiences gained under service conditions (See also *Metals & Alloys,* Vol. 5, Aug. 1934, page MA 420 R 2). The discrepancies are mainly ascribed to the exclusion of air by paraffin layers in the tests of Schwaibold & Wiesent. The superiority of "special low-corroding brines" becomes less the higher the O content of the freezing solutions. EF (13)

Corrosion in the Sugar Industry (Korrosion in der Zuckerindustrie). U. Stark. *Werkstoffe & Korrosion,* Vol. 10, Feb. 25, 1935, pages 7-9. The water for extracting sugar from beets and the partly digested beets exert an extremely corrosive action on steel. Conveyor and pump parts in contact with them had to be made of Zn-free bronze and of brass to overcome this trouble. Ha (13)

Rust Proofing Before Color Finishing. R. R. Tanner. *Monthly Review,* Vol. 21, Dec. 1934, pages 29-34. General remarks on the Parkerizing and Bonderizing treatment for steel. GBH (13)

Importance and Present Status of Corrosion Investigation (Über die Bedeutung und den derzeitigen Stand der Korrosionsforschung). W. Wiederholt. *Chemiker-Zeitung,* Vol. 59, Jan. 5, 1935, pages 25-28. Discussion of the causes of corrosion, chemical attack on Fe and non-ferrous metals, effect of pH of liquids, formation of natural protective coatings, local attack and pitting, corrosion due to non-uniformity of materials, formation of local cells, intercrystalline and selective corrosion, and corrosion at elevated temperatures. 15 references. CEM (13)

Utilization of Metals and Alloys in Sulphuric Acid Industry (Die Verwendung von Metallen und Metall-Legierungen in der Schwefelsäureindustrie). Bruno Waeser. *Die Metallbörse,* Vol. 24, Oct. 10, 1934, pages 1289-1290; Oct. 17, 1934, pages 1321-1323; Oct. 24, 1934, pages 1353-1354. Corrosion tests on various grades of Pb (analyses given) in H_2SO_4 and SO_2 are reviewed. 0.1-0.2% Cu raises the corrosion resistance of Pb at elevated temperatures. At 235° and 255° C. the service time of ordinary soft Pb could be extended 16 and 26 times respectively due to an addition of 0.2% Cu. The same effect is reported for 0.1% Na, Ca, Ba alone or combined. The superiority of hard Pb (0.1-1.8% Sb) and antimonial Pb (18% Sb) over the corrosion resistance of soft Pb is denied. Sb improves the physical properties. Bi is exceedingly detrimental. The corrosion resistance towards H_2SO_4 of Sn, Pt (and some of its alloys), Au, cast Fe, wrought Fe, Cr, Cr-Ni steels, Cr-Ni alloys with and without additions of Fe, Mo, W, Ni-resist, Monel metal, ferro-silicon, Ta, Al bronze, pure Al and silumin is discussed. Data on corrosion resistance and analyses are tabulated. EF (13)

Atmospheric and Sea Corrosion of Metallurgical Products (La corrosion atmosphérique et marine des products métallurgiques). G. Girard. *Aciers Spéciaux, Métaux et Alliages,* Vol. 9, Oct. 1934, pages 291-298. A review of the work of the Corrosion Committee in France since 1926 when it was created. This work was divided into 4 major parts: Causes and effect, Prevention, Tests and Control, and Practical Applications. GTM (13)

Theories of Corrosion (Theories de la Corrosion). G. Chaudron. *Aciers Spéciaux, Métaux et Alliages,* Vol. 9, Oct. 1934, pages 301-310. The factors of corrosion are: medium of attack, nature of the metal, and conditions of use. Rate of corrosion is measured by (a) difference of potential between the metal and that of one of its salt solutions, (b) Rate of corrosion by means of cell showing the difference of oxygen concentration, (c) By means of cathodic depolarization. The acceleration of corrosion is achieved by rapid depolarization: (1) by oxygenated water, (2) By oxygen under high pressure, (3) Alternative immersion in salt solutions, (4) Aeration of the liquid by agitation. GTM (13)

The Behavior of Metallic Materials in the Chemical Industry (Das Verhalten metallischer Werkstoffe in der chemischen Industrie) A. Bresser. *Werkstoffe & Korrosion,* Vol. 10, Feb. 25, 1935, pages 5-7. Metals and alloys are classified according to their behavior against chemical attack in 4 groups, those in which the daily dissolved amount is not more than 1 g./m.^{2}, 1-10 g./m.^{2}, 10-100 g./m.^{2}, and over 100 g. The first group is considered permanent as it takes 27 years to dissolve 1 mm. thickness. The periodic table of elements is given indicating resistance against HCl, HNO_3, H_2SO_4, food acids and m.p., and several tables show the behavior of alloys (steels, Al and Cu alloys) under the effect of chemicals. Ha (13)

Corrosion of Bearing Surfaces. C. H. Bierbaum. *Mechanical Engineering,* Vol. 57, Apr. 1935, pages 239-240. It is explained that even under the most ideal wearing conditions, i.e. where no mechanical wear of metal upon metal exists and all work is done upon the oil film, the bearing will ultimately be destroyed by the corrosion of the oil which always occurs in the course of time, unless oxidation of the oil is entirely prevented so that no chemical corrosion can take place between oil and metal. Destructive laboratory bearing tests are considered futile in this light. Ha (13)

Yellow Stain on Tinplate. C. E. Beynon & C. J. Leadbeater. *Iron & Coal Trades Review,* Vol. 130, Apr. 12, 1935, page 630. Yellow stain on tinplate is due to surface oxidation of Sn in accordance with the differential-aeration principle. The difficulties experienced in lithographic printing processes can be satisfactorily removed by stoving at 140° C. or by washing with methylated spirits. Ha (13)

Cavitation Research. J. C. Hunsaker. *Mechanical Engineering,* Vol. 57, Apr. 1935, pages 211-216. A report is made of research work to determine the mechanism by which hydraulic cavitation damages boundary walls. Although an exact elucidation of the phenomenon cannot be given at the present stage it is absolutely clear that it is entirely mechanical in nature and that there must be some connection with the fluctuation of pressure resulting from the collapse of water vapor which becomes periodically unstable in such vapor phase and causes shocks to the affected parts. The severity of the damage depends also on the shape of the boundary walls and on the air content of the water used. The test methods are fully described and erosion and cavitations obtained under different conditions illustrated. 6 references. Ha (13)

Preventing Corrosion. R. Holloway. *Electrical Review,* Vol. 116, Feb. 15, 1935, page 237. To avoid costly process of removing products of corrosion prior to finishing, castings which are to be stored should be treated with a suitable anti-rust liquid immediately after they have been cleaned and fettled. This protective coating forms a priming coat, obviating at least 1 painting operation. Manufacturers of steel products for electrical purposes should apply protective coatings to the metal when it is free from moisture, scale, and corrosion. MS (13)

Treatment of Mill Scale on Water Tanks and Standpipes. Carl A. Hechmer. *Public Works,* Vol. 66, No. 4, 1935, pages 34, 36. All steel when fabricated becomes coated with mill scale, which must be removed before paint can be made to adhere satisfactorily. Scale can be removed by (1) weathering at the mill before shipment, (2) acid pickling, (3) sand blasting after erection, or (4) omitting the usual shop coat of paint and allowing the structure to remain unpainted 6-12 months after erection; at the end of this time approximately complete oxidation of the scale has taken place and it can be removed by wire brushing. Method (4) is the most effective as well as economical. GHY (13)

Corrosion of Petroleum Tankers. Robert F. Hand. *Iron & Coal Trades Review,* Vol. 130, Apr. 19, 1935, page 657. Tankers employed in ocean transportation of petroleum in bulk are subject to very rapid corrosion. Salt water atmosphere, sea water ballast and fatigue of the material are contributing causes. The conditions are discussed and the means to reduce corrosion to the least possible degree by coating and proper selection of material are reviewed. The opinion is held, however, that fatigue stresses due to repeated cycles of reversals of stress from ballast to loaded conditions play the greatest part in corrosion of tankers. Ha (13)

The Corrosion Problems of the Naval Architects. W. H. Hatfield. *Institution of Naval Architects, Advance copy,* Apr. 12, 1935, 16 pages. Considers the corrosion of steel from 2 angles, (a) the behavior under marine conditions of steel normally used for the construction of ships, and (b) the metallurgical progress achieved in producing steels resistant to such conditions. Interesting cases of abnormal corrosion in ships' hulls are considered, and the various properties of steels resistant to marine conditions are given. JWD (13)

Evolution and Present State of Research on Corrugated Rails (Entwicklung und Stand der Riffelforschung). H. O. Lange. *Verkehrstechnik,* Vol. 15, Aug. 20, 1934, pages 434-437. A literature survey on laboratory and field tests and on the evolution of the various theories concerning the occurrence of corrugated rails is made. It is emphasized that modern wear tests yielded valuable information which will lead sooner or later to a satisfactory interpretation of this rail defect. 50 references. WH (13)

The Prevention of Bolt and Nut Corrosion in Mechanical Pipe Joints. J. A. Perry. *American Gas Journal,* Vol. 142, Jan. 1935, pages 22-25, 60. Conclusions reached indicate that insulating the bolts should reduce electrolytic corrosion. Capping the nuts and heads of the bolts with an insulating material filled with a waterproof plastic should protect them from corrosion. Shielding the heads and shanks of the bolts protects these parts. Exposed shanks of bolts between flanges should be protected by the use of waterproof compressive sleeves or grommets. Shielding the nuts of bolts with metallic shields which form an integral part of the follower ring should greatly reduce corrosion of the nuts and threaded ends of the bolts. Filling these recesses with a suitable waterproof plastic material should prevent corrosion. Suitable flexible waterproof caps forced or cemented on over the heads and nuts of bolts should eliminate corrosion of these parts. Patents are pending for many of these methods of combating corrosion. CBJ (13)

A Review of Cathodic Protection of Pipe Lines. A. F. Bridge. *American Gas Journal,* Vol. 142, Jan. 1935, pages 31-33. A negative potential of 0.2 volts (net) pipe to soil will prevent corrosion. Laboratory tests show that negative potentials exceeding 1 volt cause loss of bond between pipe metal and thin bituminous coatings, when adjacent metal is bare. Unit electrical resistance of bituminous coatings in general use varies with age and porosity, this variable is an important factor influencing the cost of cathodic protection. Ultimate economic success of cathodic protection frequently depends upon preventing continued deterioration of the coating after drainage is applied. CBJ (13)

Blistering of Iron Oxide Scales. R. Griffiths. *Sheet Metal Industries,* Vol. 8, Nov. 1934, pages 627-629; *Iron & Steel Industry,* Vol. 8, Oct. 1934, page 21. Abstract of a paper at the Autumn Meeting of the Iron & Steel Institute. See *Metals & Alloys,* Vol. 5, Dec. 1934, page MA 586. AWM + CMS (13)

Contribution to the Study of the Chemical Resistance of Various Special Steels. A. M. Portevin, E. Pretet & H. Jolivet. *Iron & Steel Industry,* Vol. 8, Oct. 1934, page 24. Abstract of paper presented at the Iron & Steel Institute Meeting in Belgium. See *Metals & Alloys,* Vol. 5, Dec. 1934, page MA 588. CEJ (13)

Corrosion of Boiler Metals. J. S. Merry. *Iron & Coal Trades Review,* Vol. 130 Mar. 8, 1935, page 418. A general discussion at a meeting of the Institution of Mechanical Engineers of circumstances leading to corrosion in boilers. Discusses quality of water, steam in steam lines and means of protection. Ha (13)

Attack of Metals by Organic Liquid Binary Systems (Das Angriffsvermögen organischer flüssiger binärer Systeme auf Metalle). Ljudevit Sladovic. *Sitzungsberichte der Akademie der Wissenschaften in Wien, Mathematische-Naturwissenschaftliche Klasse,* Abt. II B, Vol. 142, No. 10, 1933, pages 689-694. See *Metals & Alloys,* Vol. 6, Feb. 1935, page MA 76. WH (13)

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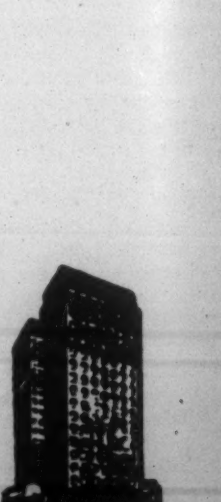

14. APPLICATION OF METALS AND ALLOYS

Comparative Performance of Watches with Elinvar and with Steel Hairsprings. Ralph E. Gould. *Bureau of Standards Journal of Research,* Vol. 12, Apr. 1934, pages 451-457. The performance of watches having the usual cut, bimetallic balance wheels and steel hairsprings is compared with that of watches having uncut, monometallic balance wheels and Elinvar hairsprings. The latter combination of vibrating assembly is a new application intended to improve performance of watches. 20 watches of each type, 10 each of 2 makes, were given performance tests at temperatures encountered in service. Marked improvement in performance at temperatures within the usual range 5°-35° C. is indicated by the use of the new assembly. The new assembly almost entirely overcomes the effects of magnetism so that, after the watch is removed from a magnetic field, the rate is not subject to fluctuations experienced with the ordinary assembly. Different positions of the watch do not show a marked difference in performance resulting from the use of the 2 assemblies. WAT (14)

14a. Non-Ferrous

G. L. CRAIG, SECTION EDITOR

American Investigations in Zinc Die Casting (Amerikanische Untersuchungen an Zink-Spritzguss). W. Claus. *Zeitschrift für Metallkunde,* Vol. 27, Feb., 1935, pages 44-45. Review of "Zinc Die Casting Alloy," E. A. Anderson and G. L. Werley, *Metals & Alloys,* Vol. 5, May 1934, pages 97-102. FNR (14a)

Die Castings, Improved in Quality, Find New Uses. *Steel,* Vol. 96, Jan. 7, 1935, pages 159, 278-279. Outlines progress in the die-casting industry during 1934. MS (14a)

The Use of Arsenic in Glass Batches. *Glass Industry,* Feb. 1935, pages 49-50. The use of arsenic for glass batch refining agent and effect on coloration or production of opalescence are reviewed. WB (14a)

14b. Ferrous

M. GENSAMER, SECTION EDITOR

Engineering Aspect of High-Strength Sheet Steels. V. H. Lawrence. *Steel,* Vol. 96, Jan. 21, 1935, pages 27-29; *Iron Age,* Vol. 135, Jan. 24, 1935, pages 28-30, 54. Summarizes opinions of engineers, fabricators, and manufacturers as to future of high-strength sheet steels, their manufacturing limitations, and primarily the value of high-strength sheets from an engineering point of view. Anticipated set-back from the growth in popularity of high-strength steels will be tendency to base applications on unit stress alone, without regard to other features involved. Discusses these items and advantages and disadvantages of producing high-strength steels by chemical composition, heat treatment, and mechanical treatment. Lists questions that must be answered in deciding on use of these steels. VSP + MS (14b)

Status and Development Possibilities of the Powdered Coal Motor (Stand, Entwicklungsmöglichkeiten und Aussichten des Kohlenstaubmotors). H. Wahl. *Stahl und Eisen,* Vol. 55, Apr. 11, 1935, pages 409-418. The report mentions the importance of powdered coal motors from the standpoint of German self-sufficiency in motor fuel. After discussing previous developments the author's newest powdered coal motor is described. A difficulty is wear of the motor parts by the dusty fuel. Partly to overcome this calls for the proper selection of the powdered coal, the motor metals, and motor design, and hence requires coöperation between the fuel chemist, metallurgist, and motor builder. The possibilities of the use of powdered coal motors for small power units, motor vehicles and freight boats, are indicated. SE (14b)

New American Steels for Machine Gun Barrels (Nieuwe Amerikaansche staalsorten voor mitrailleurloopen). *Polytechnisch Weekblad,* Vol. 28, Aug. 30, 1934, page 557. Summarizes investigations of Svechnikov on 21 different steels among which the following ones proved to be most suitable for the purpose discussed:

C	Mn	Si	Cr	V	Ni	P	S
.25	.4	.77	14.98	—	—	.006	.010
.36	1.21	.09	—	—	.81	.053	.077
.32	.11	.12	1.20	.11	—	.005	.028
.40	.55	.15	—	.15	—	.006	.031

Data on heat treatment and physical properties are tabulated. WH (14b)

Construction of the Zephyr. *Heat Treating & Forging,* Vol. 21, Apr. 1935, pages 174-176. Describes equipment and fabrication of stainless steel train. MS (14b)

Tapered Steel Posts Developed to Support Highway Guard Rails. *Steel,* Vol. 96, Feb. 4, 1935, pages 46, 49. Developed by American Bridge Company. Fabricated by successive shearing in diagonally opposite directions of rolled shapes such as standard or wide flange I-beam sections. Usually furnished with a heavy protective coat of structural galvanizing. MS (14b)

Second Stainless Steel Streamline Train is Placed in Service. *Steel,* Vol. 96, Feb. 11, 1935, pages 55-56. **The Flying Yankee.** *Heat Treating & Forging,* Vol. 21, Feb. 1935, pages 69-70. Description of stainless steel, stream-lined train of the Boston and Maine Railroad and Maine Central Railroad. MS (14b)

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15. GENERAL

RICHARD RIMBACH, SECTION EDITOR

Bibliography of Aeronautics, 1931. Published by the National Advisory Committee for Aeronautics, Washington, D. C., 1935. Cloth, 7¼ x 10¼ inches, 312 pages. Price $.50 from Superintendent of Documents, Government Printing office.

The Bibliography of Aeronautics for 1931 covers the aeronautical literature published from Jan. 1 to Dec. 31, 1931. The first Bibliography of Aeronautics was published by the Smithsonian Institution as Vol. 55 of the Smithsonian Miscellaneous Collections and covered the material published prior to June 30, 1909. Supplementary volumes of the Bibliography of Aeronautics for the subsequent years have been published by the National Advisory Committee for Aeronautics. They are the Bibliography of Aeronautics for the years 1909-1916, 1917-1919, 1920-1921, 1922, 1923, 1924, 1925, 1926, 1927, 1928, 1929, and 1930.

As in previous volumes, citations of the publications of all nations are included in the languages in which these publications originally appeared. The arrangement is in dictionary form with author and subject entry, and one alphabetical arrangement. Detail in the matter of subject reference has been omitted on account of the cost of presentation but an attempt has been made to give sufficient cross reference for research in special lines. R. Rimbach (15)-B-

The Temperature of the Copper Arc. C. G. SUITS. *Proceedings National Academy of United States of America*, Vol. 21, Jan. 1935, pages 48-50. The dependence of sound velocity upon the temperature of a gaseous medium can be employed as a pyrometric principle. At high temperatures, density changes due to dissociation of molecules and specific heat changes due to excitation must be taken into account. For the 6 amps. Cu arc, time intervals lying between 25 and 100 micro-seconds are measured for distances between 3 and 13 cm. From the experimental sound velocities the corresponding arc temperatures are found to be 4200° ± 200° K. and 4000° ± 200° K. respectively for the shorter and longer arcs. EF (15)

Temperature Measurement and Pyrometers. ALAN COTTON. *Heat Treating & Forging*, Vol. 21, Apr. 1935, pages 193-197, 203. Non-technical lecture before the Steel Treatment Research Society of Australia. MS (15)

Statistical Research (Grosszahlforschung). KARL DAEVES. *Forschungen & Fortschritte*, Vol. 10, June 1, 1934, pages 207-208. Critical discussion on laboratory experiments and plant results. Application of statistical research to metallurgical production work. Points out that the former specifications for minimum and maximum property values are more and more replaced by a demand for a high degree of uniformity. Statistical research helped to reduce the percentage of rejections from 15% to 1% and in another case from 25% to below 4% by revealing harmful influences in production work. EF (15)

Electro-Chemical and Electro-Metallurgical Processes in Modern Preparation of Raw Materials (Elektrochemische und Elektrometallurgische Verfahren bei der heutigen Rohstoffversorgung). GEORG EGER. *Metall und Erz*, Vol. 23, Feb. 1935, pages 52-58. Review. CEM (15)

Research, The Pathfinder of Science and Industry. T. A. BOYD. D. Appleton Century Company, New York, 1935. Cloth, 5½ x 8 inches, 319 pages. Price $2.50.

Written by a member of the General Motors Research Laboratory staff, this book bears the view-point of the worker in applied research, and will be of the greatest interest to other such workers. In a way, it is a technical book, for it deals with the principles of organization and administration of research, but it will be entirely understandable by the general public from the high-school student on up, for it is written in very readable style—not quite so journalese as "The Microbe Hunters," but fully as effective because there is less straining for effect. Those who are working in research, those who might take it up as a life work and those executives who have (and those who ought to have) research departments or research counselors, can all read it with interest and profit. Whenever some one else has said in a clear and striking way what the author wants to bring out, he quotes from them, so the viewpoints of Edison, Whitney, Bancroft, Jewett, Kettering, Little and many others, appear constantly. Definitions of pure and applied research, discussion of research methods, of the qualifications necessary in research workers, and general discussion of the achievements of research, form the main headings. Listed as matters essential to future development of the motor car which should be given research attention are: cheapening of aluminum, better rust proofing of iron, and finding out why a lubricant is a lubricant. Boyd's book clearly shows how unquenchable is the spirit of the research pioneer and how important to mankind are the new things that result from his work. The chapters on "economic and humanitarian dividends" are especially interesting, with their argument that the research spirit will enable us to direct our energies toward wise, effective living instead of wasting them in chasing social rainbows. Boyd does not say it, but one might conclude, that were things governmental done in the research spirit, of utilizing past knowledge and experience as the basis for further advance, and of learning from unsuccessful experiments instead of repeating them on a more and more grandiose scale, the "New Deal" would not have found itself in its present awful muddle. We note several pertinent quotations from Herbert Hoover in the book. When the philosophy of Hoover and of Boyd finally prevails and industry is freed from some of its present shackles, so the attention of executives can be devoted to other things than the troubles the administration forces upon them, research will have more attention. We hope all executives will have time and opportunity to read the book. Every research man who opens it will want to own it. When he does own it, he should lend it to all the executives he knows. H. W. Gillett (15)—B—

15a. Economic

Tin Control Critics Confounded. *Tin*, Dec. 1934, pages 6-7. A review of the results of tin control show that stocks have fallen to the desired level, the price has remained stabilized and tin consumption has continued to follow its usual relationship to industrial activity. Greater prosperity among producers is evident as indicated by Malaya which not only has a revenue surplus now but has been able to increase imports of American goods in the first half of 1934 by over 76% compared to the same period in 1933. BWG (15a)

Autos Hold Lead as Steel Consumer, Railroads Second. *Steel*, Vol. 96, Jan. 7, 1935, pages 112-114. Tabulates consumption ratios of main groups in the United States for 1922-1934, and distribution of various finished steel products in % and in gross tons to consuming groups for 1934. Latter are based on returns from 87 operating companies. Consumption of the 18,092,160 gross tons of finished rolled steel produced in 1934 was automotive, 20.87%; railroads, 12.96%; buildings, 12.70%; containers, 8.68%; exports, 5.29%; oil, gas, water, 4.97%; machinery, 3.65%; and all others, 30.88%. MS (15a)

Tin Research and Development. First General Report, 1934. *Metal Industry*, London, Vol. 45, Aug. 17, 1934, pages 153-155; Aug. 24, 1934, pages 179-181; Aug. 31, 1934, pages 202-203. A slightly condensed version of the first general report on the activities of the International Tin Research and Development Council since its inauguration. A progress report was circulated in Apr. 1933, a more general survey in Oct. 1933, but it was realized then that no adequate report could be made until a complete survey of the position with respect to Sn had been made in the chief industrial countries, particularly in the U. S. A. HBG (15a)

A Suggested Method of Establishing Melting Costs in a Grey Iron Foundry. *Foundry Trade Journal*, Vol. 51, Nov. 8, 1934, pages 290-292. Tentative proposals as submitted by the Costing Sub-Committee of the Institute of British Foundrymen. AIK (15a)

Materials for the Electrical Industry. *Electrical Review*, Vol. 116, Jan. 11, 1935, pages 59-60. Review of market conditions during 1934 for Cu, Pb, Sn, Zn, Al, and rubber. Prepared by Metal Information Bureau, Ltd. MS (15a)

Aluminum Moved Forward in 1934. W. S. MCARDLE. *Iron Age*, Vol. 135, Jan. 3, 1935, pages 143-144, 147-148. Definite gains were made in several branches of Al industry. Contributions were also made in new uses for Al. In transportation, uses of Al in all types of trucks showed increase while in some cases new carriers were designed to meet specific needs. Metallurgical developments included the widening scope of use for several alloys, introduced during 1933, though no new Al alloys were brought out. An Al-Mg-Si alloy has been selected as structural material for marine use due to its ability to resist salt water. Use of Alzak process made possible a new finish for Al. Al continues to serve the brewing industry. Closures made of Al are widely used for liquor bottles. Dairy industry used a lot of Al products. VSP (15a)

Lake Superior Iron Ore Stocks Heavy, After Season of Light Shipments. *Steel*, Vol. 96, Feb. 11, 1935, pages 25-26. Tabulates shipments in 1934 and 1933 by ranges and mines. Total shipments in 1934 amounted to 22,063,824 tons. Ore consumed during the year totaled 22,113,951 tons. MS (15a)

Gold Production in the U. S. S. R. *Mining Journal*, Vol. 187, Mar. 9, 1935, page 175; Mar. 16, 1935, page 192; Mar. 23, 1935, pages 212-214. Russian Au production in 1933 was second only to South Africa. Production in 1931 was 51,200 kg.; 1932, 59,000 kg.; 1933, 88,500 kg.; in 1934 it will be about 132.000 kg. (4,244,000 ozs.). AHE (15a)

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The Scrap Metal Market in 1934 (Die Altmetallwirtschaft 1934). *Die Metallbörse,* Vol. 25, Feb. 16, 1935, page 212. Reviews developments on German scrap metal market during the past year and presents data on 9 countries exporting Cu scrap to Germany. EF (15a)

Metal Year 1934 (Das Metalljahr 1934). *Die Metallbörse,* Vol. 25, Jan. 2, 1935, page 20; Jan. 9, 1935, page 36; Jan. 12, 1935, page 52; Jan. 16, 1935, page 68; Jan. 19, 1935, page 84; Jan. 23, 1935, page 100; Jan. 26, 1935, page 116; Jan. 30, 1935, page 132; Feb. 2, 1935, page 148; Feb. 6, 1935, page 164; Feb. 9, 1935, page 180. As in previous years, (see *Metals & Alloys,* Vol. 4, Mar. 1933, page MA 80 L-9 and Vol. 5, May 1934, page MA 239 R-9) the developments in the non-ferrous metal markets are summarized. Covers the subject under the following headings: (I) General Survey, (II) Cu, (III) Sn, (IV) Zn, (V) Pb, (VI) Al, (VII) Ni. EF (15a)

United States and World Production and Costs of Copper. Percy E. Barbour. *Mining & Metallurgical Society of America Bulletin* No. 230, Sept. 1934, Vol. 27, pages 79-97. Cu production by the leading companies is shown graphically. Domestic costs for 10 years prior to the depression were about 9.5 cents/lb., depression years 8+ cents. A weighted average cost of 66% of world Cu production in 1933 is 7.3 cents/lb. AHE (15a)

Gold, Silver, Copper, Lead and Zinc in Nevada. F. W. Horton & H. M. Gaylord. *United States Bureau of Mines, Statistical Appendix to Minerals Yearbook,* 1934, pages 11-25. Detailed figures for 1933 are presented. AHE (15a)

Molybdenum Industry in 1934—Advance Summary. Frank L. Hess & H. W. Davis. *United States Bureau of Mines, Mineral Market Reports* No. M. M. S. 358, Apr. 10, 1935, 2 pages. Mo production in the United States in 1934 was 65% more than 1933 and the greatest annual output yet made. Output of ore was 1,339,000 ton, yielding 9,119 tons of concentrate, carrying 9,362,000 lbs. of Mo. AHE (15a)

Gold Mining and Production in the United States in 1934—Advance Summary. Chas. W. Henderson. *United States Bureau of Mines, Mineral Market Reports* No. M.M.S. 350, Feb. 6, 1935, 3 pages. In 1934 the U. S. produced 3,067,389 oz. of Au, worth $107,205,247. Only New Mexico and S. Dakota decreased their output. For the U. S. there was a 19% increase. AHE (15a)

Silver Mine Production in the Western States and Alaska, 1934—Advance Summary. Chas. W. Henderson. *United States Bureau of Mines, Mineral Market Reports* No. M.M.S. 351, Feb. 8, 1935, 3 pages. Ag production in the U. S. in 1934 was 31,947,574 oz., an increase of 37% over 1933. AHE (15a)

The Economic Development of the Russian Steel Industry (Die Russische Eisenindustrie in ihrer wirtschaftlichen Entwicklung). H. Hartig. *Stahl und Eisen,* Vol. 55, Mar. 14, 1935, pages 304-310. Gives statistics of the growth of the Russian iron and steel industry during the last 10 years; also the imports and the location of the principal metallurgical centers. SE (15a)

15b. Historical

Ancient Egyptian Metal Technique (Altägyptische Metalltechnik). Günther Roederer. *Forschungen & Fortschritte,* Vol. 10, Nov. 20, 1934, pages 401-403. Discusses and illustrates the accomplishments of ancient Egyptians in the fields of bronze statues. Shows that the art of sand casting was unknown to the Egyptians, and discusses the making of composite mold by means of wax, gypsum and clay. The Greeks at first copied the Egyptian methods of utilizing models but later replaced them by hand modelling. EF (15b)

Sixty Years of Tool Progress. L. Sanderson. *Heat Treating & Forging,* Vol. 21, Apr. 1935, pages 167-169. Outlines developments in files, twist-drills, saws, lathes, and garden tools, with some consideration of materials. During this period have been developed the alloy steels, high-speed steel, Co super high-speed steels, sintered metallic powders, and welding of cutting alloys to high-grade steel shanks. MS (15b)

A Blast Furnace Nearly 200 Years Old. C. H. Vivian. *Compressed Air Magazine,* Vol. 39, Mar. 1934, pages 4361-4364. Fully describes and abundantly illustrates old blast furnace at Cornwall, Pa., which continuously operated from 1742-1883. The history of the early days of American iron industry is traced back to 1585. WH (15b)

Metals as Engineering Materials (Metalle als Werk- und Baustoffe). A. Fry. *Die Naturwissenschaften,* Vol. 23, Feb. 1, 1935, pages 78-82. Paper before the 93rd Annual Meeting of the Gesellschaft Deutscher Naturforscher & Ärzte, Hanover, 1934, historically reviews the utilization of bronze and Fe (Al) by mankind. In 1452 a bronze super-cannon was cast for Mohamet II whereby 650 hundredweights were melted in 72 hours. Homer (1000 B. C.) mentions the hardening of steel. Around 1400 the possibility of lowering the melting point of Fe by C was discovered and a remarkable cast Fe technique ensued. In 1730 Hunstman succeeded in making crucible steel. The secret did not leak out for many decades. The evolution of metallurgical science is traced emphasizing the contributions of Sorby, Martens, Ledebur, Roberts-Austen, Osmond, Gibbs, Roozeboom, Tammann, Laue, Debye-Scherrer and Ludwik. Typical phenomena such as cold working, recrystallization, aging, nitriding, creep, corrosion are discussed and illustrated. The following data (according to the speaker) represent the minimum and maximum physical properties which can be obtained with steel at present: tensile strength = 25-200 kg./mm.^{2}; hardness = 65-1300 kg./mm.^{2}; yield point: tensile strength ratio = 60-95%; specific resistance = 0.07-1.4 $\frac{\Omega \text{ mm.}^2}{\text{m.}}$ magnetic susceptibility = 0-24,000 gauss; coercive force = 0.035-1400 oersted, initial permeability = 225-12,000, coefficient of expansion = 0.0-19.0 x 10^{-6}; watt loss = 0.85 watt/kg. for 0.35 mm. sheets; heat resistance = 1300° C.; corrosion resistance even against concentrated acids like HNO_3 and acid mixtures. EF (15b)

MANUFACTURERS' LITERATURE

Radium for Industrial Radiography

This article, written by R. A. Gezelius and C. W. Briggs, containing interesting and important information on the subject, is published in handy booklet form. Radon Company, Inc., 1 East 42d St., New York, N. Y. (A 276)

Hardening and Drawing Furnaces

A colorful leaflet contains descriptions, illustrations, operating data and data on physical tests on the above subjects.

Published by the same firm: "SC Controlled Atmosphere Furnaces for Bright Annealing Steel Stampings," and "Standard Rated, Gas-Fired Oven Furnaces," leaflets describing these furnaces. Surface Combustion Corporation, Toledo, Ohio. (A 277)

Metal Melting Furnaces

Catalog No. 28 illustrates various types of this company's crucible furnaces, aluminum melting furnaces and also foundry accessories.

Published by the same firm: "Nothing is Impossible to Industry," leaflet, describes complete units for oil or gas using special composition cast pots. The Campbell-Hausfeld Co., Harrison, Ohio. (A 278)

Shield Arc Welder

Portable and stationary units are described and illustrated in Bulletin No. 302 of the Lincoln Electric Co., Cleveland, O. (A 279)

Purite's Place in Foundry Practice

Booklet P-3551 tells what Purite does when used in the cupola and when used in a fore-hearth or teapot ladle, why it purifies and turns out better castings and how it is used in practical foundry operation. The Mathieson Alkali Works, Inc., 60 East 42d St., New York, N. Y. (A 280)

Recording and Control Equipment

Bulletin No. 94 lists the requirements for automatic stress-strain recorders and states that the equipment herein described meets these requirements. Rate-of-Load Controllers and Recorder-Controllers are also illustrated and described. Baldwin-Southwark Corp., Philadelphia, Pa. (A 281)

Pot Type Furnaces

These furnaces which are used for the immersion method of heat treating small parts; for lead treatment of tools, drills, and taps; tinning, etc., are illustrated and described in a leaflet of the Hevi Duty Electric Co., Milwaukee, Wis.

Published by the same firm: "Muffle Furnaces"—Bulletin HD 535 features these furnaces which are used for laboratory operations such as drying of precipitates, ash determinations, fusions, etc. (A 282)

Double-Wall Steel Crane Wheels

Structural strength combined with the toughness and wear resistance of manganese steel, according to the manufacturer, make these wheels very economical for heavy service. American Manganese Steel Co., Chicago Heights, Ill. (A 283)

Cable Accessories

Publication GEA-1839 lists and describes the materials required for work involving the jointing and terminating of insulated cable. Fully illustrated. General Electric Company, 1 River Rd., Schenectady, N. Y. (A 284)

Convected Air Tempering Gas Heated Furnaces

Bulletin No. 40 is devoted to the above subject. The outstanding features of these furnaces are listed as well as the results to be obtained by their use. A list of typical products treated is included. Illustrated. Despatch Oven Company, Minneapolis, Minn. (A 285)

Meehanite Metal

An attractive pamphlet "The Engineer Investigates Meehanite" contains interesting information on the chemical and physical properties of this metal. Illustrated. Meehanite Metal Corp., Pittsburgh, Pa. (A 286)

Dowmetal Data Book

A new edition of this book has been necessitated by recent progress in the development of Dowmetal and rapidly increasing uses being found for this metal. According to the manufacturer, especially significant accomplishments since the last data book are recorded in those sections dealing with Available Forms and Shop Practice. The Dow Chemical Company, Midland, Mich. (A 287)

Metal Cleaning

Interesting facts concerning the Bullard-Dunn process are contained in booklet BD-23 of The Bullard Company, Bridgeport, Conn. (A 288)

Resistance Hand Book

The development of alloys to resist heat, corrosion and mechanical stresses has greatly benefited several major industries. A description and list of physical properties of the alloys manufactured by this company are featured in the hand book. Tables of useful data are to be found at the back. Wilbur B. Driver Co., Newark, N. J. (A 289)

Centrifugal Compressors

Bulletin 386 is devoted to this company's Design 9 Compressor. Illustrations and performance charts are included. B. F. Sturtevant Company, Hyde Park, Boston, Mass. (A 290)

Ampco Metal

Engineering Data Sheet No. 17 is devoted to brief descriptions of a few specific installations where this metal has proved superior. Ampco Metal, Inc., Milwaukee, Wis. (A 291)

Kramer Alloy News

This publication contains information that is of interest to users of non-ferrous ingot metals. H. Kramer & Co., Chicago, Ill. (A 292)

Furnace Draft Control

Bulletin No. 100 gives data on furnace draft and on the Shallcross electric system of draft control. Photographs and diagrams included. Shallcross Controls, Inc., Milwaukee, Wis. (A 293)

Steel Castings

A colorful folder contains leaflets which describe and list the physical properties of carbon, alloy and stainless steel castings. Many illustrations are included. Lebanon Steel Foundry, Lebanon, Pa. (A 294)

Timken Steel Specifications

A revised edition of this sheet gives the specifications for Krupp, Ni-Cr-V and special corrosion and heat-resisting steels as well as the range of alloy and carbon steel listed under S. A. E. classifications. The Timken Steel & Tube Co., Canton, Ohio. (A 295)

The Influence of Atmosphere and Temperature on the Behavior of Steel in Forging Furnaces

Engineering Research Bulletin No. 21 deals with the above subject. The major divisions of the article are: Burning and Overheating; Temperature Distribution in Steel Sections and Scaling of Steel at Forging Temperatures. American Gas Association, New York, N. Y. (A 296)

Stainless and Heat Resisting Electrodes

A colorful price list and data book containing complete descriptions of the company's products and also analyses of stainless and heat resisting alloys manufactured by other companies has been issued by Maurath, Inc., Cleveland, O. (A 297)

High Temperature Resistance Alloys

An attractive booklet is devoted to Kanthal alloys. Physical properties, instructions for using, applications and other pertinent data are included. Illustrated. A.-B. Kanthal, Hallstahammar, Sweden. (A 298)

Lindberg Furnace Control

Data sheets announcing and describing this control for electric furnaces to regulate the rate of heating. Lindberg Engineering Co., Chicago, Ill. (A 299)

Acid-Proof Equipment

Looseleaf binder containing bulletins on the subject of pumps, valves, pipe jets, kettles, coils, fans, etc. Illustrated. Duriron Company, Inc., Dayton, Ohio. (A 300)

Carbon Steels

A 62-page pamphlet dealing briefly with certain aspects of steel quality, its control in the basic open hearth process and the importance of this control to the users and consumers of steel has been prepared by The Carnegie Steel Company, Pittsburgh, Pa. (A 301)

Refractories

The manufacturers of Shamva Mullite claim it is a super-refractory because it has a definite high melting point, great resistance to sudden changes of temperature and other features. The Mullite Refractories Co., Seymour, Conn. (A 302)

Current News Items

The Testing Society's New Officers

New officers of the American Society for Testing Materials, elected at the annual meting in Detroit in June, are as follows: President (for 1 yr.), H. S. Vassar, laboratory engineer, Public Service Electric & Gas Co., Irvington, N. J.; vice-president (2 yr.), A. E. White, director department of engineering research, University of Michigan; members of the executive committee, each for 2 yrs., W. H. Graves, chief metallurgist, Packard Motor Car Co., Detroit; R. L. Hallett, National Lead Co., Brooklyn; N. L. Mochel, metallurgical engineer, Westinghouse Electric & Mfg. Co., Philadelphia; H. H. Morgan, R. W. Hunt & Co., Chicago; and W. R. Webster, chairman of the board, Bridgeport Brass Co., Bridgeport, Conn.

Frank J. Tone Honored

Frank J. Tone, president of the Carborundum Co., was awarded the honorary degree of Doctor of Science, by the University of Pittsburgh at the commencement exercises in June. In presenting Mr. Tone to the chancellor of the university for this degree, Dr. Edward R. Weidlein said:

> I have the honor to present, for the degree of Doctor of Science, Frank Jerome Tone, outstanding scientist, engineer, inventor, and executive. As president of the Carborundum company he has built up from humble beginnings two major industries, synthetic abrasives and super-refractories. One of his early accomplishments was the commercial production of metallic silicon. This achievement is still regarded as one of the major scientific feats of modern metallurgical chemistry.

Lithium and Its Uses

A valuable pamphlet entitled "Lithium—Theoretical Studies and Practical Applications" has been issued by The Electrochemical Society. It is pointed to as the most complete compilation on this subject in the English language. The author is Dr. Hans Osborg, consultant, Teaneck, N. J., a specialist in this field for many years. The foreword is by Prof. B. S. Hopkins of the University of Illinois. The price is $1.10 from the secretary, Colin G. Fink, Columbia University, New York.

The **Gray Industrial Laboratories,** 961 Frelinghuysen Ave., Newark, N. J., under the supervision of **Dr. David Drogin,** has announced the establishment of an X-ray department for the inspection and testing of materials. Equipment is said to have been specially designed and assembled to give economical service. Assembly installation and operation of equipment are under the direction of **Robert C. Woods,** formerly of the X-ray and radium research department of the Memorial Hospital, New York.

The **C. J. Tagliabue Mfg. Co.,** Brooklyn, announces the appointment of E. D. Wacker, as assistant general sales manager. Mr. Wacker has been with the company for 11 yrs., part of the time as manager of the Pittsburgh territory and more recently as division sales manager in charge of Snapon controller sales for domestic refrigerators. A considerable portion of his time will be spent in the field contacting sales representatives as well as jobbers. The company also announces that the sales of the Snapon Controller Division will be in charge of R. A. Skinner.

At the commencement exercises of the **University of Pittsburgh** in June, the honorary degree of Doctor of Science was conferred on **William A. Hamor,** assistant director of **Mellon Institute of Industrial Research.**

Announcement is made by the Harnischfeger Corp., Milwaukee, of the appointment of **Charles W. Daniels** as general sales manager for the entire line of P&H contractors' equipments, industrial products, P&H-Hansen arc welders, hoists, brewery equipment, etc. Mr. Daniels, who has been connected with Harnischfeger for many years in various capacities, was for several years in New York, but most recently in charge of the corporation's Philadelphia office. He is succeeded in Philadelphia by **L. M. Stout,** who has been appointed to fill the vacancy as district manager for that territory.

International Nickel Expands Development Staff

Mr. A. J. Wadhams, manager, development and research, The International Nickel Co., Inc., New York, has announced the addition of Harold L. Geiger to the field staff of that department. Mr. Geiger's experience has been with the operating and metallurgical departments of the Inland Steel Co. and since 1929 as chief metallurgist of the Wisconsin Steel Co., a subsidiary of International Harvester. Because of his intimate knowledge of the special problems of midwestern machinery manufacturers, Mr. Geiger will operate for the first few months out of the Detroit office of the company located in the General Motors Building. Later, he will make his headquarters in New York, where his services will be available to other industrial areas as well.

Mr. Wadhams, announces also the addition of O. W. McMullan to the research staff. He will be located in the research laboratory maintained by the company at Bayonne, N. J. He was formerly chief metallurgist at the Timken-Detroit Axle Co., Detroit. Prior to that time he was with the Studebaker Corp. Mr. McMullan is well known in metallurgical circles, principally through his authorship of numerous papers, both by himself and jointly with H. W. McQuaid.

Foundries Which Produce Meehanite

There are, as of June 15, 22 licensees of the Meehanite Metal Corp., Pittsburgh, in the United States and 11 in foreign countries. Those in the United States are the following:

CALIFORNIA: Kinney Iron Works, Los Angeles; Vulcan Foundry Co., Oakland; General Electric Co., Ontario; **CONNECTICUT**: Farrel-Birmingham Co., Ansonia; **ILLINOIS**: Greenlee Foundry Co., Chicago; **MICHIGAN**: Michigan Valve & Foundry Co., Detroit; **MISSOURI**: Banner Iron Works, St. Louis; **NEW JERSEY**: Florence Pipe Foundry & Machine Co., Florence; Warren Foundry & Pipe Corp., Phillipsburg; Trenton Malleable Iron Co., Trenton; **NEW YORK**: American Laundry Machinery Co., Rochester; **OHIO**: The Cincinnati Milling Machine Co., Cincinnati; Fulton Foundry & Machine Co., Cleveland; G. H. R. Foundry Co., Dayton; Hamilton Foundry & Machine Co., Hamilton; The Cooper-Bessemer Corp., Mt. Vernon; The Wehrle Co., Newark; **PENNSYLVANIA**: H. W. Butterworth & Sons Co., Bethayres; Rosedale Foundry & Machine Co., Pittsburgh; **TENNESSEE**: Ross-Meehan Foundries, Chattanooga; **WEST VIRGINIA**: Kanawha Manufacturing Co., Charleston; **WISCONSIN**: Koehring Co., Milwaukee.

The International Meehanite licensees are located in the following countries:

BELGIUM: Schippers-Podevyn Societe Anonyme, Hoboken-Antwerp; **ENGLAND**: Ashmore, Benson, Pease & Co., Stockton-on-Tees; Ealing Park Foundry, South Ealing, London; Winget Limited, Rochester, Kent; **FRANCE**: Establishments Zickel-Dehaitre, Paris; Societe de Produits Metallurgiques, Paris; **GERMANY**: Furstlich Hohenzollernsche, Laucherthal; A. Stotz, A. G., Stuttgart; **ITALY**: Fonderia Milanese di Acciaio Vanzetti, Milano; **SCOTLAND**: G. M. Hay Co., Glasgow; Cameron and Roberton, Ltd., Kirkintilloch, Nr. Glasgow.

Robert C. Stanley, president of **The International Nickel Co., of Canada, Ltd.,** was awarded the honorary degree of Doctor of Engineering by Stevens Institute of Technology at its sixty-third commencement exercises held in the William Hall Walker gymnasium at Castle Point, N. J., in June. Mr. Stanley is an alumnus, having been graduated in 1899 with the degree of M. E. On Dec. 14, 1933, he was elected to serve as a member of the board of trustees.

E. A. Carpenter has been elected secretary of **E. F. Houghton & Co.,** manufacturer of oils and leathers, Philadelphia, to fill the vacancy caused by the recent death of A. Everly Carpenter, III.

The appointment of **R. M. Neumann** to the position of manager of the pigment division of the **New Jersey Zinc Sales Co.,** with headjuarters in New York has been announced. Mr. Neumann succeeds the late Robert Hursh in that office.

The **Timken Steel & Tube Co.** announces the appointment of the **Edgcomb Steel Co.,** Philadelphia, as agent of the complete line of Timken steel products in the Philadelphia district. Edgcomb Steel Co. maintains extensive warehouse facilities in Philadelphia, on D Street below Erie Ave., and is well equipped to render prompt service to all alloy steel and seamless tube users in Philadelphia and surrounding territory.

Courses in Metallurgical Engineering

Announcement of courses in chemical and metallurgical engineering is made in a special pamphlet issued by the University of Michigan. The head of the department is Prof. A. H. White with A. E. White, professor of metallurgical engineering. In a statement accompanying the pamphlet, Prof. A. E. White says:

> "The chemical industry is one which has flourished during the depression and the demand for chemical engineers has continued to be fairly good. The opportunities for students with graduate training have been better than those for men who have had only the four year college course. This condition has been reflected in the attendance of students. The number of undergraduates in the department of chemical and metallurgical engineering at the university is over 300 and the number of graduate students is over 60. Since the depression commenced 46 men have received doctorates in chemical or metallurgical engineering and every one of these men is now employed in professional work."

The department of engineering research, of which A. E. White is director, organized in 1920, "has been eminently successful both from the standpoint of its clients and of the university."

Dr. Irving Langmuir Honored

The Holley Medal for 1934 was awarded on June 20, at the semi-annual meeting of the American Society of Mechanical Engineers at Cincinnati to Dr. Irving Langmuir, associate director of the General Electric Research Laboratory, for his contributions to science and engineering, especially in the development of the gas-filled incandescent lamp, of the thoriated filament for the thermionic emission, of atomic-hydrogen welding, of phase-control operation of the Thyratron tube, and in fundamental research in oil films.

Edward L. Ryerson, Jr., president of **Joseph T. Ryerson & Son, Inc.,** large steel-service organization, was recently elected to the board of directors of the New York Life Insurance Co. Mr. Ryerson succeeds Alba B. Johnson of Philadelphia who died recently. He is also a director of the Northern Trust Co., of Chicago, Quaker Oats Co., a trustee of the University of Chicago, and president of the United Community Fund of Chicago, Inc. **E. W. Langdon,** manager of the reinforcing bar division of the Ryerson Company, was recently elected president of the Concrete Reinforcing Steel Institute.

The following appointments of direct factory representatives for the sales and service of all products of the **American Electric Furnace Co.,** Boston, Mass, are announced: Anderson-Bolds, Inc., 1836 Euclid Ave., Cleveland, Ohio, for Ohio and Western Pennsylvania, the territory formerly handled by Ludwig Hommel & Co., Cleveland; W. G. Nichol Co., 711 West Michigan St., Milwaukee, for the state of Wisconsin less the western section, and **Northern Machinery and Supply Co.,** Minneapolis, for Minnesota and the western section of Wisconsin.

Effective June 1, the Buffalo, N. Y., district sales office of **Republic Steel Corp.** was removed from 475 Abbott Road to 1020 Liberty Bank Building, according to an announcement by **N. J. Clarke,** Republic's vice president in charge of sales. **Thos B. Davies** continues in charge of the office as district sales manager, assisted by his present staff.

William B. Cooley, formerly general sales manager of the Hevi Duty Electric Co., has been appointed by the **Michiana Products Corp.** of Michigan City, Ind., to handle the sales of Michiana heat and corrosion resistant alloy castings in the Indiana territory. Mr. Cooley's office is located at 433 North Capitol Ave., Indianapolis.

The **Lea Manufacturing Co.,** Waterbury, Conn., manufacturers of buffing and polishing compounds, announces the addition of **Palmer Langdon** to its research staff. He will have charge of an important piece of research work, started a year ago by the company, in abstracting and indexing all available articles and papers, published or read since 1900, pertaining to buffing and polishing. The company feels that such work when completed will be invaluable as a reference library to those in the trade producing articles requiring buffing and polishing.

A Permanent Exhibit of Metals and Plastics

On Sept. 1, a permanent exhibit of metals and plastics will be opened at Rockefeller Center, New York, by Metal Products Exhibits, Inc. The exhibition will be devoted wholly to the interests of those who specify and purchase materials and parts for industrial purposes. It will feature alloys, ferrous and non-ferrous metals, plastics, finished and semi-finished parts made from these materials, finishes for metals and plastics, manufacturing processes, designs, styling, etc. It will occupy the third floor of the International Building, the latest addition to the Rockefeller Center building program.

The officers are: President, F. P. Cummings; vice-president and treasurer, O. H. Simonds; vice-president and general manager, Herbert R. Simonds, products engineer, formerly associate editor of several magazines serving the metal working field, and author of forthcoming McGraw-Hill book on "Finishing Metal Products." In addition to the officers, the board of directors includes: Philip C. Kemp, and L. W. Hutchins, director of the American Institute and member of the firm of Sheldon, Morse, Hutchins and Easton, Inc. Robert Krogstad is director of sales for the Exhibits company, and F. A. Aubrey and J. V. Schreiber are the design experts.

Paul S. Menough, formerly of Michigan Steel Castings Co., has been appointed by the **Michiana Products Corp.,** Michigan City, Ind., makers of heat and corrosion resistant alloy castings, as representative for the Pennsylvania district. Mr. Menough's office will be located in the Chamber of Commerce Building, Pittsburgh.

The **Alloy Metal Wire Co., Inc.,** Moore, Pa., announces the recent appointment of **Donald A. Crosset** as secretary-treasurer and general manager, taking complete charge of plant production and sales activities. Mr. Crosset joined the organization at its inception, advancing to the office of secretary and engineering director prior to this new appointment. As a metallurgical engineer, Mr. Crosset brings to his new position a thorough knowledge of wire, strip and rod manufacturing in all its phases.

The **Wilbur B. Driver Co.** (formerly Gilby Wire Co.) of Newark, New Jersey, manufacturers of resistance wire for the electrical, radio, chemical, mechanical and automotive industries have just published a new 60-page resistance handbook. The manual contains a great many tables and charts pertaining to the design and construction of electrical heating units, and will be of keen interest to the engineering profession.

The appointment of **Vernon H. Schnee** to the staff of **Battelle Memorial Institute** is announced by Clyde E. Williams, director. Mr. Schnee was graduated in 1919 from Cornell University where he specialized in chemistry. He has had a wide commercial experience, especially in the development and industrial application of inhibitors, lubricants, and non-ferrous alloys, and will be employed in this field of work at the Institute.

An additional car for the original Burlington Zephyr, first of the stainless steel streamlined trains, has been completed for the Burlington Railroad by the Edward G. Budd Mfg. Co., Philadelphia. It was mounted on an ordinary railroad flatcar for shipment to Lincoln, Neb., to be inserted there in the 3-car articulated train which operates between Lincoln, Omaha, and Kansas City. The car was ordered because the Zephyr has been unable to accommodate all the passengers who wish to ride it. The car will provide 40 additional seats.

The **General Refractories Co.,** Philadelphia, announces the appointment of the **Shadbolt & Boyd Co.,** Milwaukee, as dealer agents in the Milwaukee area. The Shadbolt & Boyd company will carry a complete stock of refractories in addition to their well rounded line of industrial supplies.

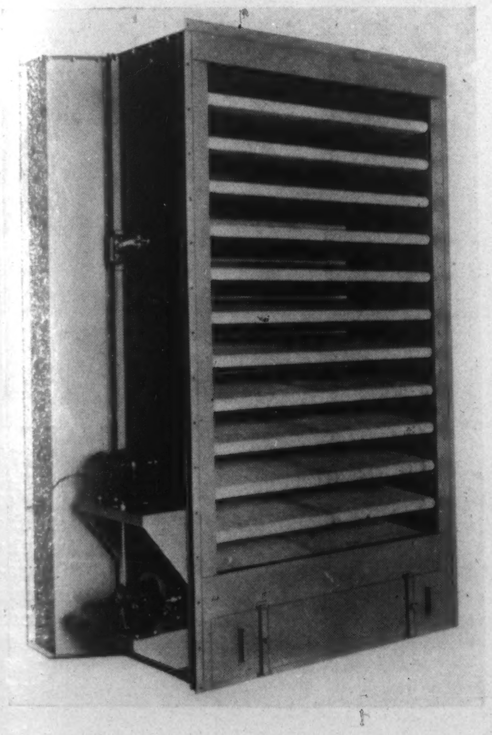
Thomas A. Wright of **Lucius Pitkin, Inc.,** addressed the New York section of The American Association of Cereal Chemists on "The Role of the Spectograph in Detecting and Determining Metals in Foods" on May 7 at the McGraw Hill Building.

New Equipment and Materials

Full Automatic, Self-Cleaning, Dry-Type Filter

The name "Dry-Matic" has been selected by the Coppus Engineering Corp. of Worcester, Mass., for its new fully automatic, self-cleaning, dry type filter. Many new features of air filter design have been incorporated into it. This new filter uses a specially woven cotton fabric as the filter medium. When the air passes through this material, the dust particles are sifted out and deposited on the filter curtain. Once a day to once a week, according to the dust concentration in the air, the filter curtain starts to move slowly over a dust drawer at the bottom of the filter housing and at the same time a rotary beater is set in operation. This may be accomplished either manually or automatically. Because of its greater operating flexibility, the manually operated push button is furnished as standard equipment on the filter. An automatic time clock that starts the motors at definite time intervals can be furnished.

Soft leather fringes beat the curtain on the clean air side with the result that all dust is shaken off into the dust drawer. After a complete cleaning cycle which lasts from 8 to 15 min., according to the height of the filter, the drive motor as well as the beater motor stops automatically. The only attention necessary for this fully automatic operation is the removal of the accumulated dust (which takes but a few minutes) from the dust drawer 3 to 4 times a year. The corporation claims the following advantages for its filter: (1) It is over 99.9 per cent efficient for dust particles of 10 micron size or larger; (2) It maintains its high cleaning efficiency even if neglected; (3) The cleaning efficiency is only slightly affected by over or under-rate of air flow; (4) It has and maintains a very low air resistance; (5) It is self-cleaning and fully automatic in operation; (6) It requires little servicing, the emptying of the dust drawer 3 to 4 times a year is all that is necessary; (7) Its cost of upkeep is negligible; and (8) The air passes through the filter curtain *only once* and cannot, therefore, pick up any dirt *after* it has passed through the curtain.



New, Light-Weight Refractory Concrete

A new type of Firecrete for casting light-weight refractory concrete on the job has just been announced by Johns-Manville, New York. Known as "L. W. (or Light-Weight) Firecrete," this new product is composed chiefly of high alumina clay calcined at high temperatures. The resulting concrete weighs only 75 lb. per cu. ft. Under continuous operation at 2400 deg. F., shrinkage is so slight as to be entirely negligible. It has withstood the most severe alternate heating and cooling tests without spalling.

"L. W. Firecrete" is 40 per cent lighter than fire brick and has 40 per cent lower heat storage capacity. This feature is of particular importance on intermittent furnaces which can be brought up to temperature in a much shorter time with less waste of heat each time the furnace cools. Because the thermal conductivity of the new material is considerably less than half that of fire brick, radiation losses are also reduced.

The material is particularly recommended for casting light-weight refractory shapes and for furnace doors and floors. It can be put in service after from 12 to 24 hr. air-curing.

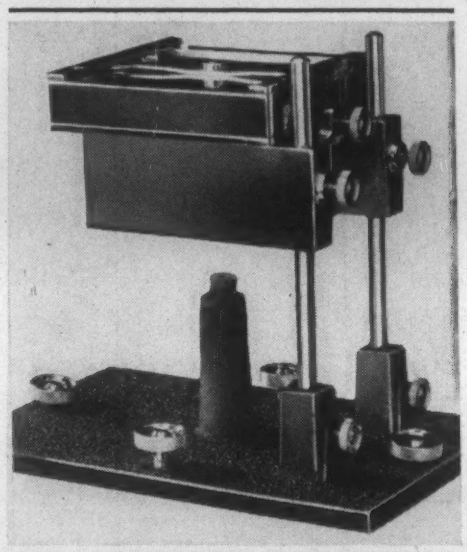
A panel of the new material, as illustrated, is easily lifted. This panel measures 4½ in. by 24 in. by 32 in. If made of ordinary fire brick, the panel would weigh 240 lb. The large face had been maintained at a temperature of 2500 deg. F. continuously for 24 hr., then subjected to a blast of cold air immediately after the burner was turned off.

Invention to Improve Fire Hose

A new method of laying fabric in wrapped fire hose to eliminate twist under pressure has been invented and patented by A. D. Maclachlan of the technical staff of the B. F. Goodrich Co., Akron, Ohio. The new construction feature will be incorporated in "White Anchor" bias-laid fire hose, which is widely used for industrial plant protection, particularly oil refineries and chemical plants. The fact that the hose remains straight when pressure is applied minimizes the danger of a "wild" hose in emergencies, and simplifies rewinding after use.

Pinhole Instrument for X-Ray Diffraction

A new pinhole instrument for high speed, high voltage, X-ray diffraction analysis of metals is announced by the St. John X-Ray Service, Inc., Long Island City, N. Y. This quick and convenient method of diffraction analysis was developed and first described by Dr. Ancel St. John in 1927 and was published in the *Transactions* of the American Society for Steel Treaters, March, 1928, Vol. 13, pages 485 to 492. It is a modification of the usual "pinhole" method using tungsten radiation at 200 kv. or more as in radiographing castings, so that for instance a powerful beam of X-rays passes through ⅛ in. of steel. If desired, entire sheets or formed articles can be mounted in the instruments, or specimens can be cut without affecting the portion to be examined. Exposures of 2 hr. or less are sufficient. The method has been applied to brass, tin, steel and other metals and their alloys in the study of mechanical working, heat treatment, extrusion, aging, the effect of exposure to gases, and the like, to determine internal strains, and so on. The new instrument, one or more, can be mounted on existing radiographic X-ray equipment and may be used simultaneously while inspecting castings or welded pressure vessels.



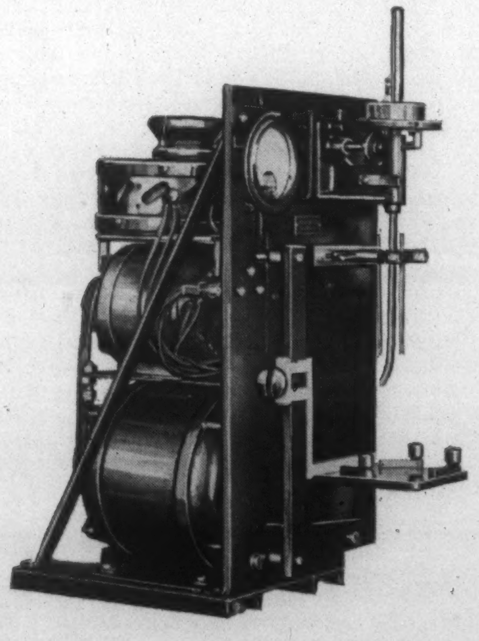
A Starter-Drive for Automobiles

In the Charter-Starter-Drive for automobiles, a product of the Burgess-Norton Mfg. Co., Geneva, Ill., the pinion is mounted on a smooth, hardened, and ground sleeve instead of the conventional screw-threaded shaft. This is said to eliminate sticking and jamming ordinarily encountered when the threads become clogged by a combination of dust and oil. The spring performs three functions. Whenever the teeth, instead of meshing properly, butt against each other the spring gives and cushions the shock. Furthermore, the driver being turned by the starting motor presses against the spring and causes the spring to turn the pinion to a mesh position, thus allowing the pinion to enter the flywheel starter gear without chewing the teeth. The other function of the spring is to both cushion and transmit the power after the driver reaches the end of the coil and the starting motor begins to turn the engine.

Charter Drive assemblies range from ½ in. and ⅝ in. for passenger car use, the ¾ in. and 13/16 in. for heavy trucks and Marine engines, to the heavy duty Diesel cranking type now standard equipment on most Diesels. Exhaustive tests are conducted on the springs, both by fatigue machines and on typical gasoline engines mounted on special blocks. Springs in every lot are selected at random and tested to destruction. As will be seen in the illustration, the spring is formed in a double coil, for greater strength, with the two ends made as a double hook for attachment to the pinion. Each hook thus fits into a slot on each side of the pinion, giving a more even application of power to the pinion through the spring and doing much to eliminate spring breakage. There are only three other major parts in addition to the spring. One is the smooth sleeve, the other is the driver, and the third is the one-piece pinion.

An Electrolytic Machine for Analytical Use

An electrolytic machine, designed on the unit power-contained system, and marketed by Eberbach & Son Co., Ann Arbor, Mich., believed to fill a need for a unified, efficient and accurate device for effecting electrolytic deposits in the determination of nickel, copper, lead, antimony, cadmium, tin, zinc, chromium and other metals. The complete unit represents a dependable and easily manipulated laboratory device. Where a large number of determinations are to be made as for instance in the rapid analysis of metals in many industrial plants, the electrolytic machine finds extensive use. In cases where 2, 4 or more sets of analyses are to be made, due to one spindle not having sufficient capacity for all the work of a given laboratory, as many units as desired can be secured. This makes for unusual flexibility as regards equipment.



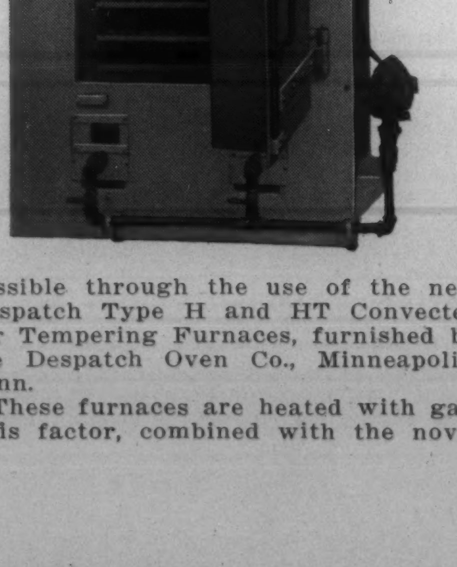
The entire unit weighs 48 lb., is rigidly mounted on a substantial framework and rests solidly on rubber feet. The front of the machine has a bakelite panel, 9 in. by 15 in., mounted on the frame so that the total height is 16½ in., and clears the table far enough to provide room for a glass tray, resting on the table. While the least corrosive materials are used, other than the noble metals, for the electrode holders, panel and shelf, it becomes desirable at times to wash off these parts with distilled water with a wash bottle. For this reason the panel is mounted high enough so as to permit the placing of a shallow photographic glass tray underneath to catch the washing water.

On the back of the panel and to the left is mounted a set of three contact plugs permitting the connection of the direct current through the electrodes for both stationary and rotating setups, as well as to change polarity when desired. A rheostat mounted on the top of the power units completes the motor-generator set and provides a ready regulation of the direct current required. Provision is also made for connecting in additional resistance in such cases where research work might require a very low current over an extended period of time, and is put in the shunt circuit of the generator reducing the voltage, as well as the current.

The power unit consists of a motor of sufficient size connected by belt drive to a generator having an output of 5 amp., 8 v., direct current. The motor also drives the stirring device which is so designed as to give speeds from 200 to 1200 r.p.m., a range wide enough to satisfy any requirement. The stirrer unit is provided with a hollow shaft to take either a chuck for clamping rotating electrode or a glass rod stirrer, when both electrodes being used are stationary. There is also provided by mounting on the panel two stationary electrode holders, both adjustable to and from stirrer shaft center. These holders are equipped with clamping devices for easy manipulation. The beaker support is adjustable up and down, and the bakelite shelf is also adjustable. Mounted on the panel is a Weston ammeter reading to 5 amp. connected in series with the generator and electrodes. For copper determination, a current of 1.3 to 1.5 amp. is the most efficient, while for the other metals a slightly higher amperage is desirable. For specific information concerning current densities, consultation with authorities on the subject should be obtained. The standard stock unit is equipped with a 110-volt, 60-cycle, a.c. motor.

Gas-Heated Tempering Furnace

Savings of 50 to 90 per cent of operating costs, more uniformly heat-treated parts, faster production, and smaller investment in tempering and drawing equipment, for temperatures from 300 to 1200 deg. F., is claimed possible through the use of the new Despatch Type H and HT Convected Air Tempering Furnaces, furnished by the Despatch Oven Co., Minneapolis, Minn.

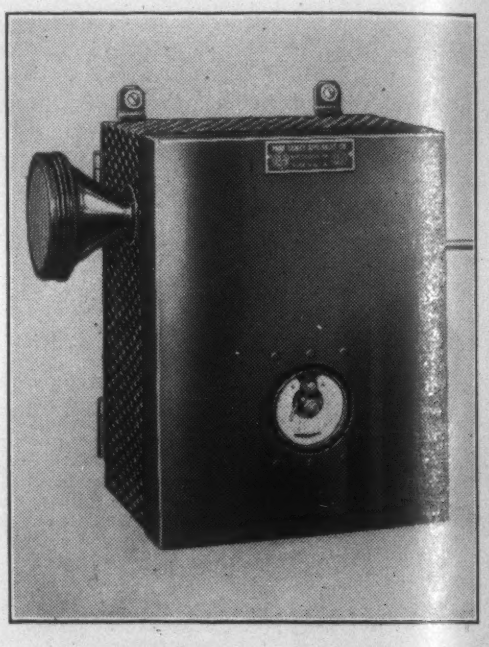


These furnaces are heated with gas. This factor, combined with the novel patented air-circulating and recirculating arrangement used in this equipment, makes additional savings possible. Up to 80 per cent of the air may be recirculated with exceptionally fine results.

Air is the heating medium. High capacity patented fan units force the heated air downward on parts being processed with pressure and high velocity swirling action, penetrating all parts of the furnace and load. Through use of special baffles, air travel through furnace is positive, and uniformly treated products are assured. Up to four changes per minute are obtained in the working chamber of furnace. By scientific application of the mechanical convection principle of heat transfer, uniformly treated products are assured and in addition, the rate of production is increased, due to faster transfer of heat to parts being processed. These new furnaces are exceptionally reasonable in price and are made in all sizes, either batch or conveyor types.

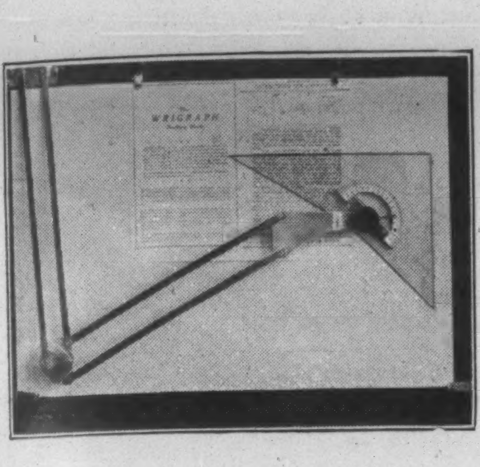
A Carbon Monoxide Alarm

The MSA Carbon Monoxide Alarm is a recent development of the Mine Safety Appliances Co., Pittsburgh. It is designed to sound a warning gong when the concentration of carbon monoxide in the atmosphere exceeds the maximum safe limit of 0.02 per cent. A small motor and pump operate continuously to draw a sample of the atmosphere under test through the detector cell in the alarm where the air is passed through a bed of hopcalite, a catalyst which converts carbon monoxide to carbon dioxide. The heat which is generated by this reaction is measured by a series of thermocouples, which are imbedded in the catalyst. The electromotive force, which is set up by the thermopile, operates an indicating relay and closes a bell circuit when the concentration of carbon monoxide in the air reaches 0.02 per cent. A number of these alarms have been put into use in steel mills and other metallurgical plants where carbon monoxide occurs. Several, also, have been installed in motor-test rooms of manufacturers of motor vehicles and in large garages.



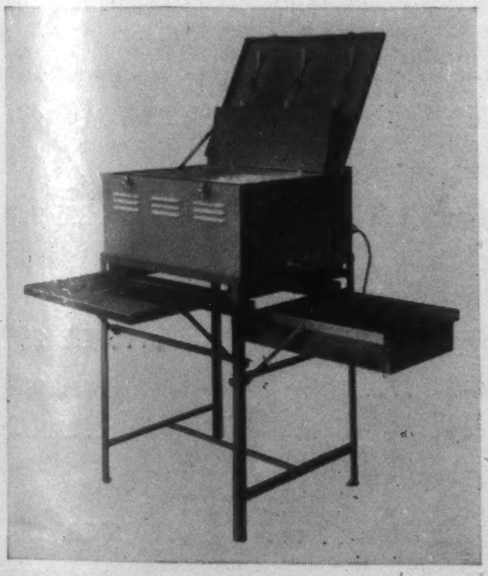
"Wrigraph" Drafting Blocks

Combining a drawing board and a drafting machine, an instrument called a "Wrigraph" and announced by L. G. Wright, Inc., 5711-14 Euclid Ave., Cleveland, is made in three sizes. The illustration shows the Model A size, 18 in. x 24 in. board and protractor triangle. The Model B has a 12 in x 18 in. board; the Junior is a complete unit with board size 10 in. x 12 in. The board is made of ¼ in. black "Presdwood" and is equipped with clips which hold either a single sheet or a pad of paper. No thumb tacks are required. The triangle attachment gives angles of 15, 30, 45, 60 and 90 deg. without reference to the protractor. The right-angle sides are graduated to ⅛ or 1/10 in. Interchangeable attachments on the parallel device make it possible for the technical man to purchase only that part of the equipment he requires. Guaranteed accuracy of an all nickel-plated parallel mechanism, assembled with Tobin bronze bearings is the feature of the "Wrigraph."



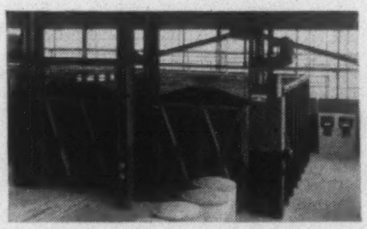
A Floor Model Blueprinter

A new model of the Angstrom lamp "Blueprinter" is announced by Milligan & Wright Co., 4713 Prospert Ave., Cleveland. This one is a floor model with a novel arrangement for the washing and fixing trays and drying boards provided in the base. The illustration shows these trays extended for use. They can then be slid back into the base so that the floor space required is only 28 x 30 in. The use of an incandescent lamp for blueprinting has long been recognized as the means of utilizing simple, inexpensive equipment, capable of being plugged into any 110-volt a.c. or d.c. light socket, but heretofore long exposures were required. This equipment produces prints with exposures of ¾ to 1½ min., depending upon the drawing and paper used. The time switch cuts off the current at the end of the exposure selected, further simplifying the operation. Companies without blueprinting equipment will find that prints which cost them 10c. can be produced on the "Blueprinter" for about 3c.



FROM TOP TO BOTTOM OF PACK
only 15° temperature variation

ABOVE: *Battery of annealing furnaces for handling black plate for tinning; also pickled and annealed stock.*



Another view of two of the Rust Box Annealing Furnaces built for the Wheeling Steel Corp., Wheeling, W. Va., by Rust Furnace Co.

PERFORMANCE DATA*

TEMPERATURE DIFFERENTIAL: 15° F. (approximately).

MAXIMUM FIRING RATE: 2600 cu. ft. natural gas per hour.

WEIGHT OF BOXES AND BOTTOMS: 17000 lbs. (approximately).

WEIGHT OF CHARGE: 68000 lbs. (approximately).

NATURE OF CHARGE: Black plate for tinning; also pickled and annealed stock for various purposes.

TEMPERATURE RISE: To bring the furnaces up to 1500° F. only eight hours are needed.

*Data supplied by Wheeling Steel Corp., Wheeling, West Virginia, for which furnaces were built.

. . . And that's only one advantage of these **RUST** *Box Annealing Furnaces insulated with Nonpareil Brick*

THERE'S no worry about uneven heating with this battery of gas-fired annealing furnaces, built for Wheeling Steel Corporation's plant at Wheeling, West Virginia, by the Rust Furnace Company, of Pittsburgh. Insulated throughout with Armstrong's Nonpareil Brick, the furnaces have a temperature differential of less than 15° F.

Heat is held in by 13½ inches of No. 2 fire brick backed up with 4½ inches of Nonpareil Brick on sidewalls, and 9 inches of No. 2 fire brick backed up with 4½ inches of Nonpareil Brick on the roof. Only eight hours are required to bring these box annealing furnaces up to 1500° F. This means a substantial fuel saving.

Nonpareil Insulating Brick is designed for use up to 1600° F., and Armstrong's Insulating Brick is recommended up to 2500° F. Armstrong's EF Brick combine insulating and refractory qualities for temperatures up to 2475° F. These light-weight insulating fire brick are used directly exposed except in cases of extreme abrasion or where slagging action is present.

For samples and complete information about all three types of Armstrong's Brick, write Armstrong Cork Products Company, Building Materials Division, 982 Concord Street, Lancaster, Pa.

Armstrong's
HIGH TEMPERATURE PRODUCTS
Armstrong's - **EF** - *Nonpareil*

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